DOCUMENT RESUME

ED 151 560 CE 015 144

AUTHOR Kim, Jin Eun
TITLE A Cost-Effectiveness/Benefit Analysis Model for Postsecondary Vocational Programs. Technical Report.
INSTITUTION Indiana Univ., Bloomington. Dept. of Vocational Education.
SPONS AGENCY Indiana State Board of Vocational and Technical Education, Indianapolis.
PUB DATE Oct 77
NOTE 80p.; For related documents see CE 015 143 and ED 130 081-082; Part of Appendixes may be marginally legible

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS *Cost Effectiveness; Data Sheets; Evaluation Criteria; Evaluation Methods; *Mathematical Models; *Post Secondary Education; Program Costs; Program Effectiveness; *Program Evaluation; Program Planning; Systems Analysis; *Vocational Education

ABSTRACT

A cost-effectiveness/benefit analysis is defined as a technique for measuring the outputs of existing and new programs in relation to their specified program objectives, against the costs of those programs. In terms of its specific use, the technique is conceptualized as a systems analysis method, an evaluation method, and a planning tool for vocational programs. To illustrate an educational systems model, three types of postsecondary vocational institutes in Indiana are identified and examined in terms of their inputs, outputs, and operations. Additionally, the threee facets of vocational program classification, time frame, and evaluation criteria are integrated in a tri-dimensional structure for evaluating postsecondary vocational education programs. A model is then presented of a system existing within a social framework, illustrating three kinds of cost-effectiveness/benefit measures it generages: (1) program effectiveness measures; (2) cost efficiency measures; and (3) cost effectiveness and performance ratios. Fifteen formulas are specified to compute these measures in evaluating postsecondary occupational programs. Data forms for determining program objectives, outputs, and costs, various computation tables, and a standard procedure for using the model are provided. (An administrator's manual for application of the model is available separately.) (DTT)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED151560

TECHNICAL REPORT

A COST-EFFECTIVENESS/BENEFIT ANALYSIS MODEL FOR POSTSECONDARY VOCATIONAL PROGRAMS

Jin Eun Kim

Department of Vocational Education
School of Education, Indiana University
Bloomington, Indiana

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

October, 1977

STATE OF INDIANA
STATE BOARD OF VOCATIONAL AND TECHNICAL EDUCATION

CE 015 144

PROJECT INFORMATION

Grantor State Board of Vocational and Technical Education
401 Illinois Bldg., 17 West Market Street
Indianapolis, IN 46204

Grant SBVTE Project Number: 13-76-C-5 (P.L. 90-576, Part C)

Grantee Indiana University
Bloomington, Indiana

Project Staff Principal Investigator and Project Director

Dr. Jin Eun Kim, Director
Cost-Effectiveness Studies in Vocational Education
School of Education
Indiana University-Bloomington

Staff

Ms. Elaine G. Eigeman, Editor
Research Dissemination Service

Ms. Diana Dicus
Administrative Secretary

Ms. Susan Schneider
Typist

Ms. Donna Shewmaker
Typist

The project reported in this publication was conducted under government sponsorship, and its author was encouraged to express freely his judgments in professional and technical matters. Points of view in the report do not necessarily represent policies of the funding agencies.

COST-EFFECTIVENESS STUDY PROJECTS

IN

VOCATIONAL EDUCATION

Project Director: Jin Eun Kim

1. *Development of A Cost-Effectiveness Analysis Model and Administrator's Manual for Secondary Vocational Programs: July 1, 1975 -- June 30, 1976.*

2. *Development of A Cost-Effectiveness/Benefit Analysis Model and User's Manual for Postsecondary Vocational Programs: July 1, 1976 -- October 31, 1977.*

3. *Diffusion of the Cost-Effectiveness Analysis System for Improving Secondary Vocational Program Management: January 1, 1977 -- December 31, 1977.*

4. *National Priority Training Project: Developmental Strategies and Evaluation Techniques for Improving the Cost-Effectiveness of Vocational Programs: July 1, 1977 -- June 30, 1978.*

ABSTRACT

Purpose. The purpose of the postsecondary cost-effectiveness project is to develop a cost-effectiveness/benefit model and user's manual for postsecondary vocational programs. The specific objectives of this report are: (1) to conceptualize cost-effectiveness/benefit analysis as a technique for evaluating postsecondary vocational programs, (2) to develop a conceptual model, data forms, and a standard procedure for using this model, and (3) to evaluate the model and data forms.

Procedures. Based upon the reviewed literature, cost-effectiveness/benefit analysis is defined as an analytical, evaluative, and planning technique, and a tri-dimensional framework is formulated for evaluating postsecondary vocational programs. Within this framework, a cost-effectiveness/benefit analysis model is developed along with data forms and a standard procedure for using the model. The Project Advisory Committee has made comments on the products and advised how to simplify them for practitioners.

Products. This technical report attempts to synthesize both cost-effectiveness and cost-benefit analysis concepts into a conceptual model for the cost-effectiveness/benefit analysis of postsecondary vocational programs. The model includes a set of program objectives and target goal statements and a program cost analysis scheme, and it generates three kinds of cost-effectiveness/benefit measures for program evaluation.

In conjunction with the model, data forms are developed which are necessary for determining program objectives and outputs and for analyzing program costs. In addition, the standard procedure delineates the specific activities in three phases: (1) planning a cost-effectiveness/benefit analysis, (2) implementing the analysis, and (3) utilizing the results from the analysis.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the State Board of Vocational and Technical Education for its financial support of the Postsecondary Cost-Effectiveness Project. Appreciation is expressed to Mr. Don Gentry, Executive Officer/State Director of Vocational Education, and to Mr. Edgar Hornback, State Coordinator for Supportive Services and Program Improvement, for their understanding and assistance in the completion of this report.

The researcher is most grateful to the Project Advisory Committee members for their advice, encouragement, and critical review of products from the project. Gratitude is also extended to Dr. Paula Carter, formerly Executive Officer of the State Advisory Council on Vocational Education and currently Associate Superintendent of the State Department of Public Instruction, for her serious consideration of and help with this study.

Special indebtedness is acknowledged to Dr. Robert Harris, the former Principal Investigator who now serves as an Associate at the National Institute of Education. Sincere thanks must go to Ms. Elaine Eigeman for editing and seeing the manuscript through to its present form, and to Ms. Diana Dicus, Ms. Susan Schneider, and Ms. Donna Shewmaker for their clerical assistance with the project and typing of this report.

ADVISORS

Dr. V.H. Broertjes, Dean
Division of General and Technical Studies
Indiana University
Bloomington, Indiana

Mr. Richard P. Koch
Vice President/Operations
Indiana Vocational Technical College
Indianapolis, Indiana

Mr. Phillip Mann
State Coordinator of Evaluation
State Board of Vocational and Technical Education
Indianapolis, Indiana

Mr. Walter Penrod
Executive Officer
Advisory Council on Vocational Education
Indianapolis, Indiana

Dr. William Richardson
Associate Professor of Agriculture Education
Purdue University
West Lafayette, Indiana

Mr. William G. Spence, Dean
Occupational Education
Vincennes University
Vincennes, Indiana

Mr. Richard Wysong, Project Director
State Board of Vocational and Technical Education
Northern Regional Service Center
South Bend, Indiana

TABLE OF CONTENTS

PAGE

CHAPTER I: INTRODUCTION 1

Objectives and Procedures 1
Organization of Report 2

CHAPTER II: A CONCEPTUAL FRAMEWORK FOR COST-EFFECTIVENESS/BENEFIT ANALYSIS OF POSTSECONDARY VOCATIONAL PROGRAMS 3

The Concept of Cost-Effectiveness/Benefit Analysis . . 3
Types of Postsecondary Vocational Institutions in Indiana 7
Tri-Dimensional Structure for Vocational Program Evaluation 10
Summary 12

CHAPTER III: A COST-EFFECTIVENESS/BENEFIT ANALYSIS MODEL FOR POSTSECONDARY VOCATIONAL PROGRAMS 13

Specification of the Model's Components 13
Measurement of Cost-Effectiveness/Benefit 22
Summary 28

CHAPTER IV: DATA FORMS AND PROCEDURES FOR USING THE MODEL 29

Data Forms for Cost-Effectiveness/Benefit Analysis . . 29
Procedure for Using the Model 31
Summary 35

CHAPTER V: EVALUATION OF PRODUCTS AND CONCLUSIONS 36

Evaluation of the Products 36
Conclusions and Recommendations 41

BIBLIOGRAPHY 44

APPENDICES 47

LIST OF FIGURES

PAGE

FIGURE 1: A TRI-DIMENSIONAL STRUCTURE FOR VOCATIONAL PROGRAM EVALUATION 11

FIGURE 2: A COST-EFFECTIVENESS/BENEFIT ANALYSIS MODEL FOR POSTSECONDARY VOCATIONAL PROGRAMS 13

FIGURE 3: ANALYTICAL SCHEME FOR COST-EFFECTIVENESS/ BENEFIT MEASURES 23

FIGURE 4: PROCEDURES FOR USING THE COST-EFFECTIVENESS/ BENEFIT ANALYSIS MODEL 31

LIST OF TABLES

PAGE

TABLE I: AN EXAMPLE OF DATA UNITS OF PROGRAM TARGET GOALS 30

TABLE II: HYPOTHETICAL DATA FOR COST-EFFECTIVENESS ANALYSIS 37

TABLE III: COMPUTATION OF COST-EFFECTIVENESS MEASURES USING HYPOTHETICAL DATA 39

TABLE IV: COMPUTATION OF COST-BENEFIT MEASURES USING HYPOTHETICAL INFORMATION 40

CHAPTER I

INTRODUCTION

This Technical Report presents a cost-effectiveness/benefit analysis model for postsecondary vocational programs which is developed for the project entitled, Development of a Cost-Effectiveness Analysis Model and User's Manual for Postsecondary Vocational Programs. The project has been conducted at Indiana University-Bloomington with the financial support of the State Board of Vocational and Technical Education. The Administrator's Manual is published separately from this Technical Report. The objectives, procedures, and organization of this report are described below.

Objectives and Procedures

The objectives of this study are: (1) to conceptualize cost-effectiveness/benefit analysis as a technique for evaluating postsecondary vocational programs, (2) to develop a cost-effectiveness/benefit analysis model and data forms, and a standard procedure for using the model, and (3) to evaluate the model and data forms to validate their use. To reach these objectives, the following procedures are used.

First, based upon the reviewed literature, cost-effectiveness/benefit is defined to combine two concepts of cost-effectiveness and cost-benefit analyses. A tri-dimensional framework is conceptualized to include program classification, criteria, and time frame for program evaluation.

Second, a conceptual model for cost-effectiveness/benefit analysis of postsecondary vocational programs is developed within the input-output framework of the social system. The primary effort is made to specify four major components and to generate three kinds of cost-effectiveness/benefit measures. Data forms and a standard procedure for using the model are included.

Third, these products have been reviewed by the Project Advisory Committee which consists of three deans responsible for administering vocational programs at two-year or four-year institutions, three state vocational officers, and one university professor in vocational education. The committee members commented on the products and advised how to simplify them for practitioners. Their suggestions were incorporated into the development of program objectives and goal statements, cost analysis scheme, and data forms. To increase the usefulness of the model and data

forms, hypothetical data were used to test the cost-effectiveness/benefit measures developed in the model.

Fourth, quarterly reports on the progress of this study have been submitted to the state project monitor and the university accounting officer. The study started in July, 1976, and finished in October, 1977.

Organization of Report

This report consists of five chapters. Chapter II describes concepts of cost-effectiveness/benefit analysis, types of postsecondary vocational institutions, and tri-dimensional aspects of program evaluation.

Chapter III presents a cost-effectiveness/benefit model for postsecondary vocational programs. Four major components of the model are specified and three kinds of cost-effectiveness measures are described along with appropriate formulas for computing these measures.

Chapter IV presents data forms for determining program objectives, outputs, and cost analysis. A standard procedure is conceptualized for using the model and data forms.

Chapter V discusses the uniqueness of the products, examines cost-effectiveness/benefit measures, draws conclusions, and makes recommendations for future studies. Finally, the report includes supporting documents in the references and appendices.

CHAPTER II

A CONCEPTUAL FRAMEWORK FOR THE COST-EFFECTIVENESS/BENEFIT ANALYSIS OF POSTSECONDARY VOCATIONAL PROGRAMS

This chapter describes the concepts of cost-effectiveness and cost-benefit analysis, the types of postsecondary vocational institutions, and an educational systems model for postsecondary institutions. Then it presents a tri-dimensional structure for vocational program evaluation.

The Concept of Cost-Effectiveness/Benefit Analysis

By operational definition, cost-effectiveness/benefit analysis is an analytical technique. For specific purposes of its use in this study, the technique is conceptualized as an analytic, evaluative, and planning tool.

Definition of Cost-Effectiveness/Benefit Analysis

The concepts of cost-effectiveness and cost-benefit analysis have been viewed in a number of different ways. Quade (1967) defines cost-effectiveness analysis in a broad sense as an "analytical study designed to assist a decision-maker in identifying a preferred choice among possible alternatives," and, narrowly, it is a "comparison of alternative courses of action in terms of their costs and their effectiveness in attaining some specific objectives" (pp. 1-2).

Cost-effectiveness analysis is defined as the systematic examination and comparison of alternative courses of action on the basis of the assessment of both (1) direct and indirect costs and (2) gains and benefits (Bension, 1968, p. 257). Knezevich (1973) defines cost-effectiveness analysis as a systematic examination of an alternative in terms of its advantages, as measured by a fixed outcome, and disadvantages, as measured by the economic cost (p. 326). When analyzing the cost and effectiveness of educational programs, Forbes defines effectiveness as "a measure of the achievement of program objectives" (p. 21).

Cost-benefit analysis is defined as the "systematic examination of an alternative as determined by the economic value (advantages) of the alternative as related to its economic costs (disadvantages)" (Knezevich, 1973, p. 326). As an economic analysis technique for assessing

alternative programs, cost-benefit analysis compares the costs and the resulting monetary benefits of programs. By assessing both inputs and outputs in monetary units, cost-benefit analysis generates three criteria: (1) the expected net present value, (2) the benefit-cost ratio, and (3) the expected internal rate of return (Stromsdorfer, 1972, p. 12).

In general, cost-effectiveness analysis and cost-benefit analysis are distinguished from one another by their different output measures of effectiveness and benefit, even though they both relate their output measures to the common denominator of costs (input) (Kim & Harris, 1976, pp. 8-9). Whereas the measure of effectiveness is not the same as the measure of costs, the measure of benefits is the same as the measure of costs (Knezevich, 1973, p. 326; Forbes, 1974, p. 21; Levin, 1975, pp. 92-3; Rossmiller & Geske, 1976, p. 489). In other words, effectiveness is measured by the degree of achieved program objectives, while benefit is measured in a monetary unit.

However, when viewing costs as inputs, and effectiveness and benefits as outputs, both cost-effectiveness and cost-benefit analysis can be integrated into a single input-output framework. Thus, a combined analytical technique can be used in which two approaches are employed for analyzing the cost-effectiveness and cost-benefit of existing and/or new programs. This combined approach, called cost-effectiveness/benefit analysis, is defined as a technique for assessing the outputs of existing and/or new programs in relation to their specified program objectives and measuring them against the costs of those programs. The technique can be used for systems analysis and the evaluation and planning of vocational programs.

Cost-Effectiveness/Benefit Analysis as Systems Analysis

Both cost-effectiveness analysis and cost-benefit analysis are popular components of systems analysis. According to Knezevich (1969), systems analysis is "an analysis or a review of systems and operations. It starts with a description of systems as they presently exist, analyzes interrelations among variables, relates the benefit that accrues to the cost incurred, and prepares organizational and systems data pertinent to decision making" (p. 545). Banghart (1969) views systems analysis as "an attempt to define the most feasible, suitable, and acceptable means for accomplishing a given purpose" (p. 25).

A cost-effectiveness/benefit analysis includes a series of activities such as the definition of measurable objectives, identification of alternative ways of achieving the objectives, determination of the cost and effectiveness or benefit trade-offs from each alternative, and identification of the optimum alternative (Cary, 1972, p. 61; Hatry & Cotton, 1967, p. 15; Knezevich, 1973, p. 185). These activities are of significance in the Planning-Programming-Budgeting System (PPBS) context. For example, when the government was adopting the PPB system,

President Johnson requested each federal administrative department to develop its objectives and goals, to evaluate each of its programs to meet these objectives by measuring the benefits against the costs, to examine alternative means of achieving these objectives, to shape its budget request on the basis of this analysis, and to justify that request in the context of a long-range program and financial plan (Lyden & Miller, 1968, p. 5). From this perspective, cost-effectiveness analysis can be integrated into a PPB system and can perform the functions of:

1. Clarifying and specifying the ultimate goals or objectives of each activity for which a government budgets money.

2. Gathering like activities into comprehensive categories of programs designed to achieve the specified objectives.

3. Examining as a continuous process how successful each activity or program has been, i.e., its effectiveness.

4. Analyzing proposed improvements or new program proposals to see how effective they might be in achieving program goals.

5. Projecting the entire costs of each proposal not only for the first year, but for several subsequent years.

6. Formulating a plan which is based in part on the analysis of proposed cost and effectiveness and which leads to implementation through the budget, (Mushkin, 1967, p. 1).

Thus, the main function which cost-effectiveness/benefit analysis can offer in a PPB system is to provide criteria for comparing various alternative programs in terms of the total value of their achievements over their total costs. The analysis can be also undertaken whether or not such analysis is integrated into a PPB system. The analytical results can be used by persons concerned with economic efficiency to maximize program achievements from scarce resources. The analysis can provide decision-makers with useful criteria by which to allocate and use a given set of resources to meet numerous competing needs in rational and optimal ways. A cost-effectiveness/benefit analysis of vocational education programs can identify the most desirable program among competitive vocational programs and can increase economic efficiency by allocating a given amount of resources to the most worthy of vocational programs.

Cost-Effectiveness/Benefit Analysis as an Evaluation Method

Both cost-effectiveness and cost-benefit analysis are methods of evaluation research (Struening & Gutlentag, 1975). "The cost-effectiveness method was developed primarily by military analysts in their evaluation of weapon systems" (Levin, 1975, p. 93); whereas cost-benefit

analysis is "employed mostly by economists for evaluating changes in social situations and the relative desirability of different collective policies" (Rothenberg, 1975, p. 55). Cost-effectiveness/benefit analysis is a method of evaluation research which is not only capable of determining strategies which maximize the desired effects from any particular resource, but is also capable of evaluating such social programs as water resource development, urban renewal, model cities, and education.

The purpose of evaluation is to obtain information with which to make choices among alternative policies or programs which are designed to achieve social objectives (Levin, 1975, p. 89). Kaufman (1968) views cost-effectiveness/benefit analysis as a method for evaluating vocational education programs by means of "(1) the analysis of measured quantities in terms of the attainment of objectives and progress toward goals, (2) an estimate of the value of existing programs in determining this progress, and (3) an estimate of the costs involved" in conducting these programs (p. 10).

When evaluating vocational education programs, there are three main questions to be answered: (1) Is the program effective, or to what extent are the program objectives being achieved? (2) How efficient is the program in terms of unit costs per output? (3) Does the program perform in an effective and efficient manner? Cost-effectiveness/benefit analysis can be used to investigate these questions and to make appropriate measurements of effectiveness, efficiency, and performance in order to determine whether existing vocational programs should be continued, expanded, modified, or deleted. In addition to its use in program evaluation at the operations level, the analysis can be used for developing new, alternative programs, and for evaluating their potential for achieving certain objectives in terms of their projected costs. Used this way, the analysis enables program planners to replace their existing program with an effective alternative program.

Cost-Effectiveness/Benefit Analysis as a Planning Tool

Cost-effectiveness/benefit analysis can be used as a planning tool for educational development. In his discussion of the use of cost-effectiveness analysis in long-range planning, Schwarz (1968) includes these components: (1) the setting of objectives, (2) forecasts of future environment, (3) determination of different alternatives, and (4) determination of a preferred course of action considering the objectives, possibilities, and constraints (p. 32). Carpenter and Haggart (1970) view cost-effectiveness analysis as a tool that can assist the educational planner in relating the resources required by an educational program to its effectiveness. They contend that the analysis can be used to: (1) help assess the relative worth of rural innovative programs that have similar educational outcomes, (2) determine whether a simple program is becoming more or less effective as time passes, or (3) help assess the potential worth or a program in different school settings (pp. 1-2).

Cost-benefit analysis has made important contributions to the understanding of investments in educational planning (Woodhall, 1970). The use of a rate-of-return approach in cost-benefit analysis is a means of integrating educational and economic planning (Correa, 1975, p. 29). In one practical application of the rate-of-return approach, the individual and social incomes associated with various levels and types of educational attainment are compared with the individual and social costs of providing the particular types of education. The results from this analysis can provide useful criteria for making investments in education and for allocating resources within the levels and types of programs.

Thus, the use of cost-effectiveness/benefit analysis is an essential part of program planning which relates resources to outputs. The analysis can be used to plan new vocational education programs that maximize the effectiveness and benefits of available resources, or it can be used to maintain a high level of efficiency in existing programs.

Types of Postsecondary Vocational Institutions in Indiana

Three types of the postsecondary vocational institutions in Indiana are classified according to their distinct administrative approaches. Then the inputs, outputs, and operations of these postsecondary vocational institutions are examined as parts of an educational systems model.

Types of Postsecondary Vocational Institutions in Indiana

The different kinds of opportunities in postsecondary vocational-technical education which are open to students in various parts of the country reflect the differences among institutions that offer programs. According to Venn's report (1964), forty-eight different institutional titles are classified into three distinct administrative approaches in the publicly supported institutions which work in the field of vocational-technical education. The program may be administered (1) at the local or community level in specially created two-year college districts, (2) by a designated state board, or (3) by the state university (p. 86). The postsecondary institutions that typically offer one- or two-year vocational and technical programs are junior and community colleges, technical institutes, area vocational schools, trade and technical schools (usually proprietary), and the senior colleges and universities (Riendeau, 1975, p. 151).

In the state of Indiana, three types of publicly supported postsecondary vocational institutions are identifiable. First, Indiana Vocational Technical College (IVTC) is a unique system which was founded by an Act of the Indiana General Assembly in 1963. IVTC provides occupational education through a coordinated system of 13 regional institutions which are located throughout the state. All programs are administered

by the State Board of Trustees at the central administrative office and by regional boards of trustees at the regional institutions. IVTC is a college with an open-door admission policy and programs which are designed to meet the individual occupational goals of students. To achieve this, IVTC has established a series of curricula structured to provide a multiple-entry, multiple-exit opportunity for skills acquisition by the student (PROJECT 21, p. II-3, CATALOG, 1976).

Vincennes University is a state- and county-supported comprehensive junior college. It provides: (1) the first two years of transferable college work, (2) a series of occupational programs which teach job entry skills, (3) adult and continuing education programs, (4) a broad program of general education for all students, (5) opportunities for personal development, and (6) community services. The university maintains an open-door admission policy. Any student with diploma from a recognized high school may enroll and receive counsel as to the type of program he should undertake. Students without high school diplomas can often be helped to overcome deficiencies and may be admitted to occupational programs if there is evidence of ability to carry the work (PROJECT 21, p. II-26; 1976-77 CATALOG, p. 7, 10).

Two-year associate degree or certificate programs in occupational education are also conducted at Indiana University, Purdue University, Indiana State University, and Ball State University. The traditional choice between a high school diploma and a four-year college degree is being expanded to meet a wider range of individual goals and economic needs. There are various occupational programs which include certificate and less-than baccalaureate degree programs. For admission to one of these programs, high school graduation with good grades is required.

The administration of these postsecondary vocational programs is in the hands of each college or university president under the authority of each respective board of trustees. For statewide planning and coordinating purposes, however, all budgets and new vocational program offerings must receive approval from the State Board of Vocational and Technical Education and be reviewed by the Indiana Commission for Higher Education (Senate Enrolled Act No. 85, Code of Operational Procedure, 1975).

The Postsecondary Vocational Institution as an Educational System

The postsecondary institution for vocational education can be viewed as an educational system. Furthermore, its educational production process can be explained by a systems model which consists of (1) inputs to the system, (2) outputs of the system, and (3) operations of the system.

Inputs to the System. Factors external to the educational system influence the nature of educational goals, program development, and the level of funding, especially in the field of vocational education. A community's population characteristics, values, expectations, and man-

power needs strongly influence the nature of schooling. The community's economic resources and its willingness to support vocational education affect the amount and quality of human and material resources available to vocational programs. These external inputs can be summarized as the community demand and support for vocational education.

The most significant external input to the educational system is students (Rossmiller & Geske, 1976, p. 496). The U.S. Office of Education suggests that students be classified by their characteristics into two categories: (1) regular students, and (2) special students who are gifted, mentally retarded, physically handicapped, emotionally disturbed, or culturally disadvantaged (Handbook II, 1973, p. 24). In addition, students can be characterized according to (1) their sex, age, and ethnic identity, (2) their individual needs for vocational education, and (3) the socio-economic status of a student's family, including their parents' education and annual income.

Outputs of the System. The outputs of an educational system can be classified in a number of different ways, including short-range and long-range, cognitive and noncognitive, or monetary and non-monetary (Rossmiller & Geske, 1976, p. 499). Others classify the outputs into the effects on the student, school, and community (Abt, 1969, p. 677).

Short-range outputs can be described in terms of student achievements, manual skills, and program completion and/or graduation. For those concerned with the community effects, long-range outputs can indicate the impact of the system upon the individual and social incomes and upon the community's productive life, such as citizen participation in governmental affairs, crime rates, and number of public assistance recipients (Rossmiller & Geske, 1976, p. 500).

Operations of the System. The system operates to achieve the mission and educational goals assigned to its vocational programs within a public policy framework. Federal legislation defines the aims, priorities, and controls for vocational education. A state may control educational policy for planning, implementing, and evaluating vocational programs based on federal and state legislative authority. At the institutional level, the community supplements state policy controls by establishing its own objectives and goals through the board of trustees. The academic institution has to set forth objectives and establish the relative importance of goals and priorities for the vocational programs.

To achieve the institutional goals and program objectives, academic administrators must organize meaningful programs and relevant learning activities, recruit professional personnel, and secure such material resources such as the physical plant, instructional equipment, and classroom and laboratory facilities. A major task of academic administrators is to identify the most appropriate manner in which the available student inputs of human and material resources can be combined to achieve program goals and objectives while operating within the constraints imposed by the external factors.

In order to utilize the available resources effectively and efficiently, the administrative personnel must be familiar with various resource mixes as well as the community that the institute serves. They can enhance vocational programs and student training, using only available resources, with the cost-effectiveness/benefit analysis technique.

Tri-Dimensional Structure for Vocational Program Evaluation

When evaluating vocational programs, it is necessary to clarify the program's classification, the time frame for the study, and the evaluating criteria which will be used. The three facets of vocational program evaluation which guide the development of a cost-effectiveness/benefit analysis model for postsecondary vocational programs follow.

Vocational Program Classification

The U.S. Office of Education suggests a set of seven vocational program areas and sub-programs. They are: (1) agriculture, (2) distributive education, (3) health occupations, (4) home economics, (5) business and office, (6) technical education, and (7) trade and industry (see U.S.O.E. 1969). The Higher Education General Information Survey (HEGIS) provides six categories of "Technological and Occupational Disciplines Leading to Associate Degrees and Other Awards Below the Baccalaureate." The technological fields include: (1) business and commerce, (2) data processing, (3) health services and paramedical, (4) mechanical and engineering, (5) natural science, and (6) public service related (Gulko, 1972, pp. 90-91). Thus, the postsecondary vocational programs can be classified by either the U.S. Office of Education's recommendation or the HEGIS taxonomy.

Some postsecondary vocational programs are divided by degree level into associate degree programs, certificate programs, and proficiency programs. There are also programs which transfer to colleges for the baccalaureate degree. Thus, some programs extend to other programs, whereas others are terminated by a degree lower than the baccalaureate degree.

Time Frame

All program evaluations must begin with an annual cost analysis. Therefore, one-year program completion is the most basic function for any program evaluation. Later two-year graduation and/or follow-up studies can be developed which are based on this initial evaluation. In the one-year time frame, program objectives should be developed to measure short-term and long-term effectiveness and annual and accumulative costs should be analyzed to determine the internal and external efficiency of post-secondary vocational programs.

Criteria for Evaluation

Three kinds of cost-effectiveness/benefit measures can be used as criteria for evaluating postsecondary vocational programs. First, effectiveness can be measured by dividing program outputs by program objectives. Second, efficiency can be determined by the unit cost per completion or graduate and a cost-benefit ratio. Third, performance and cost-effectiveness ratio can be made by relating effectiveness measures to efficiency measures.

These three aspects of program evaluation can be integrated into a tri-dimensional structure as shown in Figure 1. The structure provides

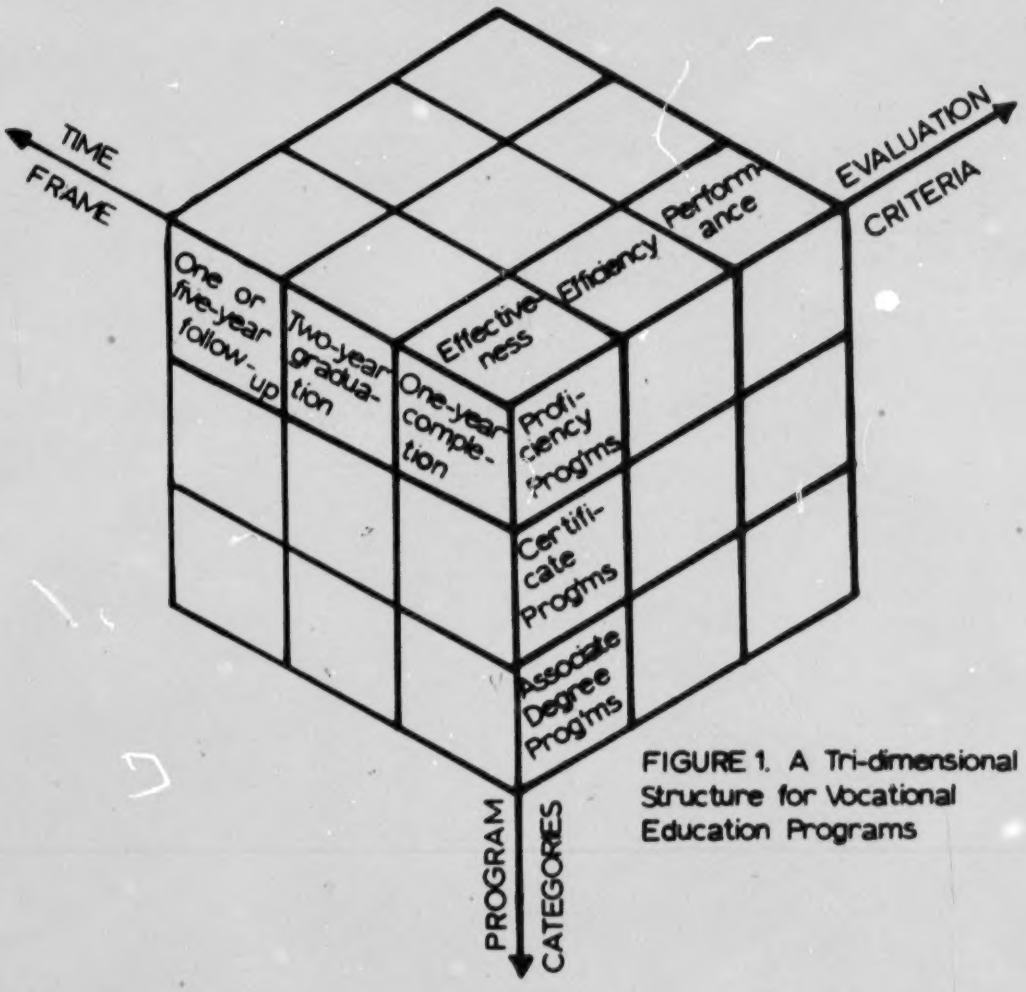


FIGURE 1. A Tri-dimensional Structure for Vocational Education Programs

evaluators with an evaluation scheme integrating degree-level program classification, evaluation criteria, and time frame. For example, associate programs can be evaluated according to the criteria of effectiveness, efficiency, and/or performance degree on the basis of one-year completion, two-year graduation, and/or follow-up study. The scheme is flexible in determining the scope or boundary of program evaluation as a sub-part or as the whole structure.

Summary

A cost-effectiveness/benefit analysis is defined as a technique for measuring the outputs of existing and new programs in relation to their specified program objectives, against the costs of those programs. In terms of its specific use, the technique is conceptualized as a systems analysis method, an evaluation method, and a planning tool for vocational programs.

Three distinct types of postsecondary institutions for vocational education are identified within the state of Indiana. Then their educational processes are explained in terms of an educational systems model which considers the inputs, outputs, and operations of the postsecondary vocational institutions.

Three facets of vocational program classification, time frame, and evaluation criteria are integrated to build a tri-dimensional structure for evaluating postsecondary vocational education programs. The structure will be useful for evaluation because it helps clarify the boundary of vocational program evaluation as a sub-part of the total structure or as a whole.

CHAPTER III

A COST-EFFECTIVENESS/BENEFIT ANALYSIS MODEL FOR POSTSECONDARY VOCATIONAL PROGRAMS

A comprehensive model has been developed for the cost-effectiveness/benefit analysis of postsecondary vocational programs which uses the input-output framework. The purpose of the model is to generate three kinds of cost-effectiveness/benefit measures for the vocational programs: (1) program effectiveness, (2) cost efficiency, and (3) cost-effectiveness and performance ratio.

Specification of the Model's Components

The cost-effectiveness/benefit analysis model includes: (1) social demand and support, (2) student input, (3) vocational programs for analysis, (4) program objectives, (5) program outputs, and (6) program costs. The three measures and the relationships among all model components are shown in Figure 2. Each of the components is described below.

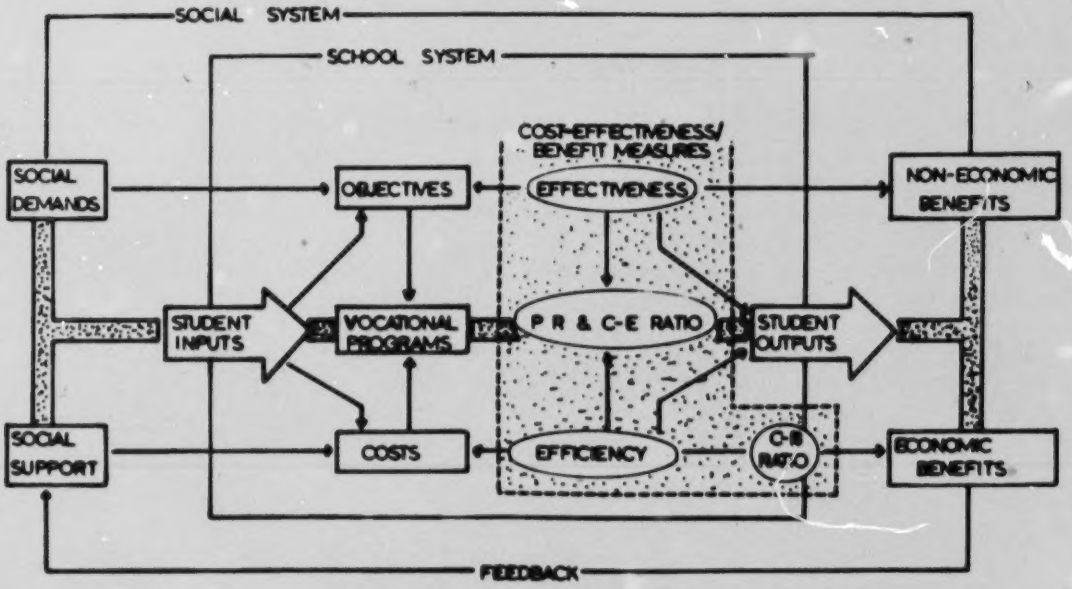


FIGURE 2 A COST-EFFECTIVENESS/BENEFIT ANALYSIS MODEL FOR POSTSECONDARY VOCATIONAL PROGRAMS

Social Demand and Support

Social demand and support for postsecondary vocational programs are included in the model as external factors to the postsecondary vocational institution. The social demand component identifies population trends, mobility of residents, and manpower needs. Specifically, its sources of data are annual population growth, age distribution, sex and ethnic group ratios, employment and unemployment data, and manpower projections. The community's level of economic resources and willingness to support vocational programs determine the amount and quality of human and material resources available to operate vocational programs. These economic resources and support are measured in terms of family income levels and tax revenues, taking into consideration changes in the level of support over a period of time due to inflationary factors.

This social demand and support information can be collected using social indicator forms developed by the Executive Office of the President (1973). The information is not directly related to cost-effectiveness/benefit analysis, but it will be useful for determining program objectives and interpreting the analytical results from the cost-effectiveness/benefit study.

Student Input

Student characteristics data are included in the model as input to the school system, in terms of their role in determining program objectives and costs. The U.S. Office of Education suggests the classification of student characteristics into two categories: (1) regular students, and (2) special students who are gifted and talented, mentally retarded physically handicapped, emotionally disturbed, or culturally disadvantaged (Handbook II, 1973, p. 24). In addition to such characteristics, student input data include such personal data as age, sex, previous vocational training and experience, educational achievement and aspiration, and future job expectations; and such family background data as parents' job, educational level, and income level.

These student characteristics data can be identified by a previously conducted descriptive survey by Cross (1968). She describes the characteristics of junior college students in terms of (1) academic characteristics, (2) socioeconomic background, (3) finances, (4) self-concepts, (5) interests and personality characteristics, (6) reasons for attending and reactions to college, (7) choice of vocation and major field of study, and (8) educational and occupational aspirations.

Vocational Programs for Analysis

The postsecondary vocational programs can be classified by either the U.S. Office of Education's code system or HEGIS classification scheme. The proposed model is directed to analyze cost-effectiveness/

benefit of the postsecondary vocational sub-program areas or courses. In other words, the model is concerned with specialized vocational and technical instructional programs such as accounting or marketing within the business program area.

Sub-program areas or courses within the vocational program area can be selected for analysis. Although the primary concern is with the analysis of individual programs, a comparison of cost-effectiveness/benefit can be made, where necessary, among vocational instructional programs and/or different institutions.

Program Objectives and Target Goal Statements

The objectives of the postsecondary vocational education can be stated in terms of student-oriented goals and institutional commitments to achieve these goals. Referring to the production and maintenance of organizational goals, Gross and Grambsch (1968) define university goals by: (1) output goals which are reflected in some product, service, skill or orientation and (2) support goals which include adaptation, management, motivation, and position goals (pp. 13-16). In a similar way, Cross (1975) specifies three goals and four roles of vocational education. The three goals are: (1) equipping all persons for earning a living, (2) preparing skilled workers for available jobs, and (3) preparing persons to live life more fully. The four roles suggest these organizational commitments to obtain those goals: (1) cooperating with industry, (2) providing relevant education, (3) meeting student needs, and (4) serving as a change agent.

In addition to the general purposes of education, the vocational program has to meet individual personal needs as well as social manpower demands for the specific occupational field. The earliest and most widely accepted objective of vocational education was "to provide a mechanism for meeting the manpower needs of the local community" (Evans, 1971, p. 9). Even though the Vocational Education Act of 1963 did not reject manpower needs, it turned the emphasis of the vocational program toward meeting the needs of people. In their mission statements, the postsecondary vocational institutions in Indiana emphasize various occupational programs to meet both personal needs of people and manpower demands of the society.

On the basis of these overall purposes of vocational education, the postsecondary vocational education program objectives which have been developed in this model are stated as administrators' tasks for the operation of occupational programs at the postsecondary institution. The program objectives are organized in a time frame in which they are matched with such factors as: (1) enrollment, (2) preparation and completion, (3) placement and advanced studies, which indicate immediate achievements, and (4) job satisfaction and economic benefits, which indicate long-range achievements. These program objectives are specified as follows:

1. Students will be enrolled in the postsecondary occupational program to meet their educational needs.

2. Students enrolled in the postsecondary occupational program will complete the requirements of the program and be prepared for career development.

3. Program completers will be placed according to their training in jobs which will meet manpower demands.

4. Some students will elect advanced studies after completion of the program.

5. Program completers will increase their job satisfaction, status, and economic benefits.

Furthermore, each of the program objectives is specified in measurable terms according to the target goals which it aims to achieve. The first objective is specified by a total number of enrolled students, number (or percent) of special students, and percent of sex-free enrollments in the program traditionally considered sex-stereotyped. The second objective is stated in measurable target goals by the percent of students enrolled who receive available information for career preparation, complete program requirements, receive a certificate or associate degree, and pass licensure examinations relating to the institution's specific programs.

The target goals for the third objective include the rate of placement as a whole, in specialized and related jobs, and within or outside the state; as well as the evaluation of employed completers in personal, social, and job skills by their employers. The fourth objective is specified by the percentage of graduates involved in an equivalent specialty in an allied program for advanced studies and by the rating which those graduates give to their previous program as a foundation for their advanced studies.

Target goals for the fifth objective measure the percent of employed completers reporting high job satisfaction and job advancement related to their training in the previous program, and increased monetary benefits made by the individual and the community as a result of the program training.

A suggestive and not exclusive set of the program objectives and target goal statements for a cost-effectiveness/benefit analysis is given in Appendix A. Statements can be selected with consideration to institutional and program uniquenesses. Appropriate information about social demands and student characteristics should be fully utilized when setting target goals. Both administrators and faculty should take a part in determining target goals as well as selecting appropriate objectives.

Program Outputs

Program outputs are the products or expected results from the program. They are often expressed in terms of results or impacts of the school system. The National Center for Educational Statistics (1973) classifies fifty-eight different educational outcomes into three phases: (1) primary effects (product consumption and investment), (2) secondary effects (feedback from investment and consumption), and (3) tertiary effects (intergenerational impacts). Clemmer, et. al., (1974) identify performance indicators, such as student test results and the number of students completing graduation requirements, and societal indicators, such as the employment rate of graduates (p. 3).

In this model, program outputs are defined as the actual attainments of predetermined objectives and target goals because these attainments are the desired outcomes which result from a postsecondary occupational program. Accordingly, program objectives and target goals are compared with actual achievements of enrollment, career preparation, program completion, placement, advanced study, job satisfaction, and economic benefits.

Student output units, such as the number of enrollments, student credit hours, program completers, and graduates are identified when computing the unit costs of a vocational program. The long-range goal of increased private and social monetary benefits is measured by students' earnings after completion of their training in an occupational program.

Program Costs

Program costs can be defined by amounts expended for operating the occupational program at the postsecondary institutional level. By this definition, foregone income for the time of students while they are in the program are not counted in the costs of occupational programs. Operating expenditures are to be analyzed on a one-year and/or two-year basis to determine annual cost and/or two-year cost expended for the program operation.

Postsecondary occupational program costs are analyzed in themselves or in relation to their monetary benefits (e. g., Koch, 1972, in Illinois; Richardson, 1972, in Missouri; Sorenson, 1972, in California, and Sewell, 1974, and Webb, 1974, in Wisconsin). These analyses employ different definitions and items of costs. For example, Koch uses three types of costs: the direct costs paid by students for their training, the direct costs paid by society, and the foregone income of the students who are receiving the training (p. 7). In Richardson's study, direct costs are divided into two categories: current operating costs consisting of administrative, instructional, operational, and maintenance costs, and capital outlay for equipment needed to operate vocational programs (p. 45).

In an effort to eliminate confusion, the proposed model defines program costs in two ways. When the analysis is concerned with comparing program costs with immediate program effectiveness, only annual operating expenditures are used, whereas students' foregone income is added to the operating expenditures when the analysis attempts to compare program costs with long-range monetary benefits.

Direct Costs. The expenditures for the operation of occupational programs can be divided into direct costs and indirect supporting service costs. Direct costs of an occupational program are defined as expenditures directly related to the program and classified as (1) salaries, (2) employee benefits, (3) purchased services, (4) supplies and materials, and (5) capital outlay.

1. Annual salaries of teaching staff within the occupational program. The total cost of salaries for the teaching staff including support faculty and technical instructional staff can be assigned to the program on the basis of teaching time allotted to a given program, using the following formula:

$$AS = \sum_{i=1}^{n} F_i \cdot T_i \ (\%)$$

Where, AS: Annual Salaries
F_i: Annual Salary of individual faculty and staff
T_i: % of annual teaching time allotted to a given program

2. Fringe benefits for teaching staff within the occupational program. Fringe benefits for the teaching staff are accounted for by certain amounts of the fringe benefits paid by the institution on behalf of teaching staff within the program. One method for computing the amount of fringe benefits is to add actual amounts paid by the institution for (1) retirement, (2) social security, (3) medical insurance, (4) life insurance, and (5) other benefits, on the basis of teaching time allotted to the program. The total of fringe benefits is computed by:

$$FB = \sum_{i=1}^{n} (R_i + S_i + M_i + L_i + O_i) \cdot T_i \ (\%)$$

Where, FB: Fringe benefits assigned to the program
R_i: Retirement contributions
S_i: Social security contributions
M_i: Medical insurance pensions
L_i: Life insurance pensions
O_i: Other benefits
T_i: % of annual teaching time allotted to a given program

The other method is to multiply total salaries assigned to the program by a certain percent of fringe benefits paid by the institution as follows:

$$FB = AS \cdot P\ (\%)$$

Where, FB: Fringe benefits
AS: Annual salaries of teaching staff
P: % of the salaries for fringe benefits

3. Purchased services. Purchased services include amounts paid for the personal services of individuals who are not on the regular payroll and for travel for instructional purposes. When a portion of the instructional service is provided by individuals on a special or part-time basis, expenditures paid for these purchased personal services can be included as a component of direct costs. Travel costs are annual amounts of mileage expense and per diem paid to teaching staff who travel for instructional purposes related to the program.

4. Costs of instructional supplies and materials. These costs are expenditures for consumable supplies and materials for instructional purposes. If expenditures for supplies and materials are allocated to all occupational programs, the expenditures should be prorated to each program on the basis of student credit hours. The cost of instructional supplies and materials costs can be assigned to the program by the following:

$$ISMC = \frac{sch}{SCH} \cdot C\ (\$)$$

Where ISMC: Instructional supplies and material costs for a given program
sch: Student contact hours for the program
SCH: Total student contact hours for all occupational programs
C: Total supplies and material costs for all occupational programs

5. Costs of instructional equipment used by the occupational program. These costs are total amounts of yearly depreciated costs, including repair and replacement expenses of instructional equipment. Depreciated costs can be estimated by dividing original costs by life expectancy. If the use of equipment is shared with other programs, the annual costs should be prorated to a given program on the basis of percentage of use in the program. Annual cost can be computed as follows:

$$IEC = \sum_{i=1}^{n} \frac{OC_i}{Y_i} \cdot X(\%)_i$$

Where, IEC: Instructional equipment costs
OC_i: Original costs of items
Y_i: Life expectancy of items
X: % of use of items in the program

6. Cost of instructional space used by the occupational program. The annual cost of building space used by the program can be determined by dividing the original cost by life expectancy (Handbook II, p. 168), and multiplied by proportion of space and time used for the program. It is expressed by:

$$AISC = \frac{OC}{Y} \cdot \frac{is}{IS} \cdot \frac{t}{T}$$

Where, AISC: Annual instructional space cost
OC: Original cost of instructional space
Y: Life expectancy
is: Instructional space used for a given program
IS: Total instructional space
t: Hours for use in the program
T: Total hours for use in all instructional programs

When analyzing program costs within the institution, the instructional space costs can be excluded from the direct cost of the program. However, if the analysis attempts to compare program costs between institutions or to develop new programs which may need new facility acquisitions, then building space use costs must be considered.

Indirect Costs. Prorated expenditure for administrative and support services can be considered as indirect costs of the occupational program. The indirect costs can include: (1) departmental administration and support service costs, (2) college administration and support service costs, and (3) institutional administrative and support service costs. These indirect costs can be prorated to individual programs through the following procedures:

1. Departmental administration and support service costs prorated to the occupational program. These costs include salaries of department chairperson and support staff and costs of departmental supplies and expenses. Total amounts of expenditures for departmental administration and services can be prorated to the instructional program on the basis of student credit hours by using the formula which follows:

$$PDASC = \frac{sch}{DSCH} \cdot DASC$$

Where, PDASC: Prorated departmental administration and support service costs to the occupational program
sch: Student credit hours within the program
DSCH: Total student credit hours within the department
DASC: Departmental administration and support service costs

2. College administration and support service costs prorated to the occupational program. These costs include salaries of the deans and support staff and the cost of supplies and expenses at the college level. Total expenditures for college administration and support service can be prorated to the occupational program on the basis of full-time equivalent teaching staff by the following:

$$PCASC = \frac{fte}{FTE} \cdot CASC$$

Where, PCASC: Prorated college administration and support service cost to the occupational program.
fte: Full-time equivalent teaching staff within the program
FTE: Full-time equivalent teaching staff within the college
CASC: Total college administration and support service costs

3. Institutional administration and support service costs prorated to the occupational program. These costs are amounts paid for those activities and services associated with (1) institutional administration, (2) libraries, (3) student services, (4) physical plant operation and maintenance, and (5) auxiliary services for faculty and students.

Institutional administration costs may be prorated to the occupational program on the basis of full-time equivalent teaching staff as follows:

$$PIAC = \frac{fte}{TFTE} \cdot IAC$$

Where, PIAC: Prorated institutional costs to the program
fte: Full-time equivalent teaching staff within the program
TFTE: Total full-time equivalent teaching staff within the institution
IAC: Total expenditures for institutional administration

Library and student services costs can be prorated to the occupational program according to proportion of students enrolled in the program over total number of students in the institution.

Costs for physical plant operation and maintenance can be prorated to the occupational program by dividing the proportion of instructional space used by the program by the total building space including non-instructional space and multiplying by the total expenditures for plant operation and maintenance. It is expressed by:

$$PPOMC = \frac{is}{TBS} \cdot x\ (\%) \cdot POMC$$

Where, PPOMC: Prorated physical plant operation and maintenance costs to the occupational program
is: Instructional space used by the program
TBS: Total building space including non-instructional space
x: Instructional space use time for the program
POMC: Total expenses for plant operation and maintenance

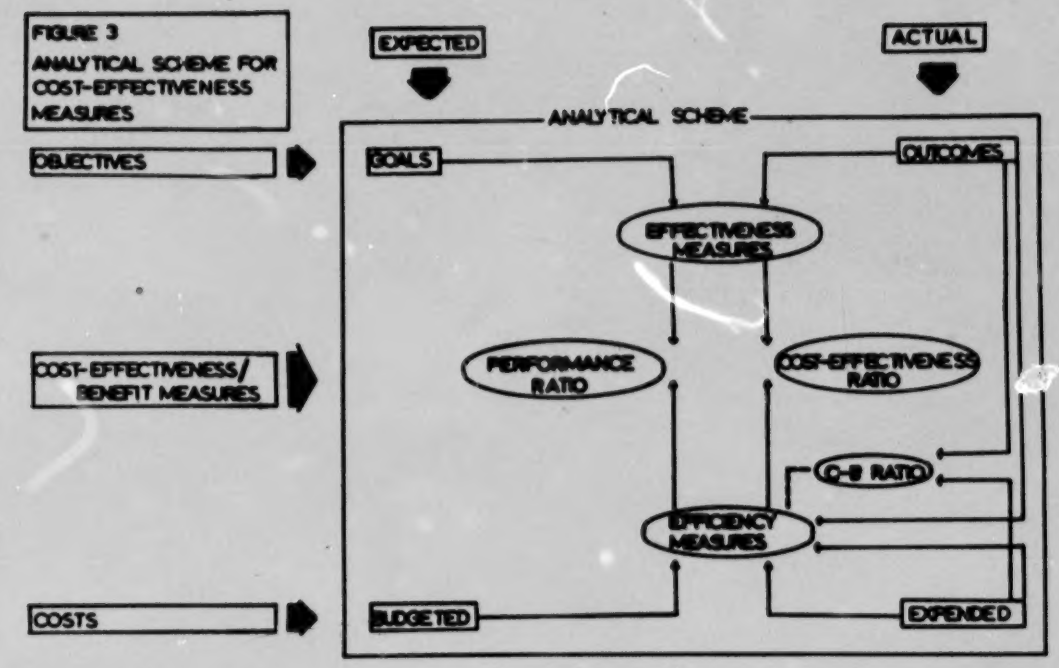
Auxiliary service costs for faculty can be prorated to the occupational program according to the proportion of teaching staff involved in the program, and auxiliary service costs for students can be prorated according to the portion of students in the occupational program.

After these prorating procedures are completed, the prorated costs of all administrative and support services are added to the indirect cost of the occupational program. Finally, the sum of direct and indirect costs represents the total cost of the occupational program.

Aside from these costs, student foregone income can be accounted for by average earnings of high school graduates who are not enrolled in postsecondary education programs. A total of program operation and student opportunity costs can be compared with graduates' future earnings as monetary benefits.

Measurement of Cost-Effectiveness/Benefit

Based upon information about program objectives, outputs, and costs, the model purports to generate three kinds of cost-effectiveness/benefit measures. For this purpose, an analytical scheme has been developed which is shown in Figure 3. Basically, effectiveness is measured by the relationship between target goals and actual outcomes, and benefits are accounted for in monetary units by long-term outcome. Efficiency is measured by the unit costs concept and also by the relation-



ship of expended costs to budgeted costs or standardized costs. The final products of the model are a meaningful cost-effectiveness ratio, which is computed by dividing the effectiveness index by unit costs, and a performance ratio, which is computed by dividing the effectiveness index by the efficiency index. The model develops formulas for computing (1) program effectiveness, (2) cost efficiency, and (3) cost-effectiveness and performance ratio.

Program Effectiveness and Benefits

Effectiveness is a measure of the extent to which an objective is achieved. Program effectiveness, which indicates a degree of program goal attainment, is made by dividing program outputs by target goals. A number of program effectiveness scores can be combined into an effectiveness index. A composite effectiveness index is made by adding all available effectiveness scores. Dividing the composite index by the number of scores provides an average effectiveness index. If effectiveness scores are weighted according to the priority of their program objectives, a weighted composite and average effectiveness index can be made using the same procedure. Program benefits can be measured by students' future earnings after graduation. Program effectiveness and benefit measures can be computed through the following formulas:

Program effectiveness (PE_i) scores are derived by dividing program outputs (PO_i) by target goals (TG_i), or

$$PE_i = \frac{PO_i}{TG_i} \text{ ----------(Formula 1)}$$

A number of these program effectiveness scores can be added to a composite program effectiveness (CPE) index, and an average program effectiveness (APE) index can be made by dividing the composite (CPE) index by the number of program effectiveness scores (N). They are expressed by:

$$CPE = \sum_{i=1}^{n} \frac{PO_i}{TG_i} \text{ ----------(Formula 2)}$$

$$APE = \frac{\sum_{i=1}^{n} \frac{PO_i}{TG_i}}{N} \text{ ----------(Formula 3)}$$

If each program effectiveness score is weighted on the basis of policy preference or the importance of program objectives, then a weighted composite program effectiveness (WCPE), and a weighted average program effectiveness (WAPE) index can be made as follows:

$$WCPE = \sum_{i=1}^{n} \frac{PO_i}{TG_i} \cdot W_i \text{ ----------(Formula 4)}$$

$$WAPE = \frac{\sum_{i=1}^{n} \frac{PO_i}{TG_i} \cdot W_i}{\sum_{i=1}^{n} W_i} \text{ ----------(Formula 5)}$$

As long-range target goals, monetary benefits are measured by students' future earnings after program completion. The benefits, which are the result of increments of training in the occupational program, constitute an income stream over a student's lifetime (Thomas, 1971,

p. 22). A dollar received today will increase at a compound rate of interest. Therefore, one dollar in future earnings is equivalent to a smaller amount of money today; this present value is arrived at by discounting the rate of interest. Thus, a discounted stream of future income determines the present value of the income. In other words, the process of computing present value is called discounting, and an interest rate is used as the discount rate by which the present value of the sum of future income is computed. If the rate of interest is r, the present value (PV) of a future income (I) of dollars per year for a number of years (n) beginning with year t=1 is computed as follows:

$$PV = \sum_{t=1}^{n} \frac{I_t}{(1+r)^t} \text{ ----------(Formula 6)}$$

Increased income (II), which is the result of training in the post-secondary occupational program, can be determined by subtracting from the average annual income of the program completers (I) the average annual income of high school graduates who are not enrolled in postsecondary programs (I'). A total of increased incomes (TII) is a sum of increased incomes at the given annual growth rate (k) which is expressed by:

$$TII = \sum_{t=1}^{n} (I-I')\ (1+k)^{t-1}, \text{ or } \sum_{t=1}^{n} II\ (1+k)^{t-1} \text{ -------(Formula 7)}$$

The present value of these increased incomes ($PVII_o$) can be computed by the following:

$$PVII_o = \sum_{t=1}^{n} \frac{II\ (1+k)^{t-1}}{(1+r)^t} \text{ ----------(Formula 8)}$$

Cost Efficiency

Efficiency is a measure of the relationship between costs and units of program outputs. Internal efficiency is measured by unit costs; total program costs are divided by the total number of students, student credit hours, or program completers. Performance efficiency can be determined by the ratio of the occupational program's actual costs over its budgeted or standardized costs. Furthermore, external efficiency can be measured by the relationship between student program costs and program completers' future earnings which is shown by a cost-benefit differential and ratio or by the rate-of-return of the investment in the occupational program. The formulas for computing cost efficiency measures follow.

Internal efficiency (IE) is measured by dividing a total actual cost ($C_{(a)}$) by either the total number of students (S) enrolled in the occupational program, student credit hours (SCH), or program completers (PCO). Each of these quotients is a unit cost ($UC_{(a)}$). The formula is:

$$IE = \frac{C_{(a)}}{S}, \frac{C_{(a)}}{SCH}, \frac{C_{(a)}}{PCO}, \text{ or } UC_{(a)} \quad \text{----------(Formula 9)}$$

If budget costs for the occupational program are analyzed, budgeted unit costs ($UC_{(b)}$) can be computed in the same way as Formula 9, above.

A performance efficiency (PE) index can be computed by dividing the actual unit cost by the budgeted unit cost. If average or standard cost information is available, the actual unit cost ($UC_{(a)}$) is compared with the average unit cost (AUC) or standard unit cost (SUC) to produce a performance efficiency index. Accordingly, performance efficiency (PE) is expressed by the following:

$$PE = \frac{UC_{(a)}}{UC_{(b)}}, \frac{UC_{(a)}}{AUC}, \text{ or } \frac{UC_{(a)}}{SUC} \quad \text{----------(Formula 10)}$$

Furthermore, external efficiency is defined as a relationship between student program costs and completers' future incomes. It can be measured by comparing the student program costs with the stream of future incomes, which will result in three measures: (1) the net present value, (2) the cost-benefit ratio, and (3) the internal rate of return of the investment in postsecondary occupational education.

The net present value (NpV_0) of future incomes is the difference between the present value of costs (C_0) which are program costs plus student opportunity costs in the initial year and the present value of increased incomes ($PVII_0$) at the given discount rate (r). It is expressed by:

$$NpV_0 = \sum_{t=1}^{n} \frac{II\ (1+k)^{t-1}}{(1+r)^t} - C_0 \quad \text{----------(Formula 11)}$$

The cost-benefit ratio (C-BR) is measured by dividing the present value of increased incomes ($PVII_0$) by the present value of total costs (C_0). The ratio is greater or less than unity. It is expressed by:

$$C\text{-}BR = \sum_{t=1}^{n} \frac{II\ (1+k)^{t-1}}{(1+r)^{t}} \div C_o \qquad \text{(Formula 12)}$$

The internal rate of return is that interest rate (r) which makes the present value of increased incomes equal to the present value of costs, or a sum of ratios of annual growth rates to the interest rates is equal to the ratio of the present value of costs to the increased income. It is found by using the following equation:

$$\sum_{t=1}^{n} \frac{II\ (1+k)^{t-1}}{(1+r)^{t}} = C_o, \text{ or } \sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}} = \frac{C_o}{II} \qquad \text{(Formula 13)}$$

These external efficiency measures are used as investment criteria by themselves in the cost-benefit analysis of postsecondary occupational programs. In an effort to help practitioners complete these cost-benefit measures, tables for $(1+k)^{t-1}$, $(1+r)^{t}$, $(1+r)^{-t}$, and $\sum_{t=1}^{n} (1+k)^{t-1}\ (1+r)^{-t}$ have been developed and samples of them are included in Appendix D. The use of the cost-benefit measures can be separated from the following cost-effectiveness and performance ratios.

Cost-Effectiveness and Performance Ratios

The final product of the model is a meaningful cost-effectiveness ratio and a performance ratio. The cost-effectiveness ratio (C-ER) is measured by dividing one of the program effectiveness indices (Formulas 2, 3, 4, and 5) by unit cost (Formula 9) as follows:

$$C\text{-}ER = \frac{(2),\ (3),\ (4),\ \text{or}\ (5)}{(9)} \qquad \text{(Formula 14)}$$

The ratio indicates the degree of goal attainment per unit cost. This computation of a cost-effectiveness ratio is somewhat different from the commonly used method which divides outputs by the total or unit costs as inputs (Knezevich, 1973, p. 204; Handbook II, 1973, p. 70). The latter method lacks effectiveness measures, therefore, its product can be called a cost-output ratio rather than a cost-effectiveness ratio. The proposed model defines effectiveness measures and produces a cost-effectiveness ratio.

The performance ratio (PR) is generated from the division of program effectiveness indices by a performance efficiency index (Formula 10) as follows:

$$PR = \frac{(2),\ (3),\ (4),\ \text{or}\ (5)}{(10)} \qquad \text{(Formula 15)}$$

This performance ratio indicates more or less than unity when using an average program effectiveness index. It is a precise index which measures management performance by representing the relationship between program effectiveness and cost efficiency. Therefore, the ratio should be interpreted with consideration to effectiveness and efficiency implications when it is used to evaluate occupational programs.

Summary

An attempt has been made to develop a comprehensive model for the cost-effectiveness/benefit analysis of postsecondary occupational programs. The model consists of (1) social demand and support, (2) student input, (3) vocational programs for analysis, (4) program objectives and target goal statements, (5) program outputs, and (6) program costs. It generates three kinds of cost-effectiveness/benefit measures: (1) program effectiveness measures, (2) cost efficiency measures, and (3) cost-effectiveness and performance ratios. Fifteen formulas are designed to compute the three kinds of cost-effectiveness/benefit measures for evaluating postsecondary occupational programs.

CHAPTER IV

DATA FORMS AND PROCEDURES FOR USING THE MODEL

This chapter describes the data forms which are necessary for collecting data required for conducting a cost-effectiveness/benefit analysis of postsecondary occupational programs. Then it presents a standard procedure for using the cost-effectiveness/benefit analysis model.

Data Forms for Cost-Effectiveness/Benefit Analysis

A cost-effectiveness/benefit analysis requires appropriate data pertaining to each of the major components. The model specifies data units for the cost-effectiveness/benefit analysis of postsecondary occupational programs and combines them into data forms for (1) program objectives and outputs and (2) program cost analysis.

Data Form for Program Objectives and Outputs

The proposed model is designed to analyze the cost-effectiveness/benefits of vocational programs at the postsecondary institution level. Determination of program objectives and outputs requires data on enrollment in and completion of the vocational instructional program, on career preparation, and on follow-up information pertaining to job placement, advanced studies after graduation, and long-term achievements.

For Objective One in the model, necessary data includes a total enrollment number and the numbers of disadvantaged, handicapped, male, and female students enrolled in the program. Objective Two requires data on enrollments, on recipients of available information needed for career preparation, a certificate, or an associate degree, on students who complete the program requirements, and on those who pass licensure examinations.

For Objective Three, immediate follow-up data is needed on job placement of completers, on employment within and outside the state, and on employers' satisfaction with occupational and social skills of employees. Objective Four requires student records on graduate advanced studies in an equivalent or allied program. Finally, Objective Five's data requirements include long-range follow-up information on employed

completers' job satisfaction, salary increase, job advancement, and increased earnings by the individual and by the society.

Data units for program objectives can be identified by dividing a factor unit by a basic unit of the specific target goal. For instance, the target goal of Objective 1-b can be determined by dividing the number of disadvantaged students who are expected to enroll in the program (factor unit) by a total number of students to be enrolled (basic unit) and multiplying the result by one hundred, as illustrated in Table I.

Table I

AN EXAMPLE OF DATA UNITS OF PROGRAM TARGET GOALS

Objective 1-b	*Basic Unit*	*Factor Unit*	*Target Goal*
____percent of the enrollments will include disadvantaged students	a total number of students enrolled	number of disadvantaged students enrolled	$\frac{\text{Factor Unit}}{\text{Basic Unit}} \times 100 = \_\_\_\%$

Program outputs can be assessed by the same data units as used for program target goals. The output of Objective 1-b can be determined by dividing the number of disadvantaged students who are actually enrolled in the program factor unit by the total number of enrolled students (basic unit) and multiplying the result by one hundred. The data form needed for determining program target goals and outputs is illustrated in Appendix B.

Data Form for Program Cost Analysis

Program costs include both direct instructional costs and indirect administrative and support services cost. The direct costs are those expenditures including (1) annual salaries of teaching staff, (2) fringe benefits for teaching staff, (3) purchased services, (4) instructional supplies and materials, (5) instructional equipment, and (6) building space use cost. The indirect costs include annual expenditures for (1) departmental administration and support services, (2) school (college) level administration and support services, and (3) institutional administration and support services.

Cost data can be classified in different ways, and the items to be included for a cost-effectiveness/benefit analysis can vary according to individual decision needs, ranging from a minimum effort to assess

only direct program operational costs to a maximum effort to collect all program costs and student costs. When evaluating an individual program or comparing two or more programs within an institution, it may not be necessary to consider indirect costs. However, if the analysis is concerned with comparison of vocational programs between institutions, then indirect costs must be considered. Furthermore, because the analysis is designed to generate a cost-benefit ratio, the total of program costs and student costs should be compared with the monetary benefit achieved by the individual or by the society.

A computing procedure for program costs is developed into a summarizing data form. The data form for program cost analysis is illustrated in Appendix C.

Procedure for Using the Model

Administrative awareness and commitment to the use of the cost-effectiveness/benefit analysis model encourages the staff to develop a plan for a cost-effectiveness/benefit analysis. After implementing the analysis, the administrator can utilize the results in the decision-making processes of program evaluation, development, and planning. Based on these assumptions, a standard procedure has been developed which includes three phases: (1) planning a cost-effectiveness/benefit analysis, (2) implementing the analysis, and (3) utilizing the results (Figure 4).

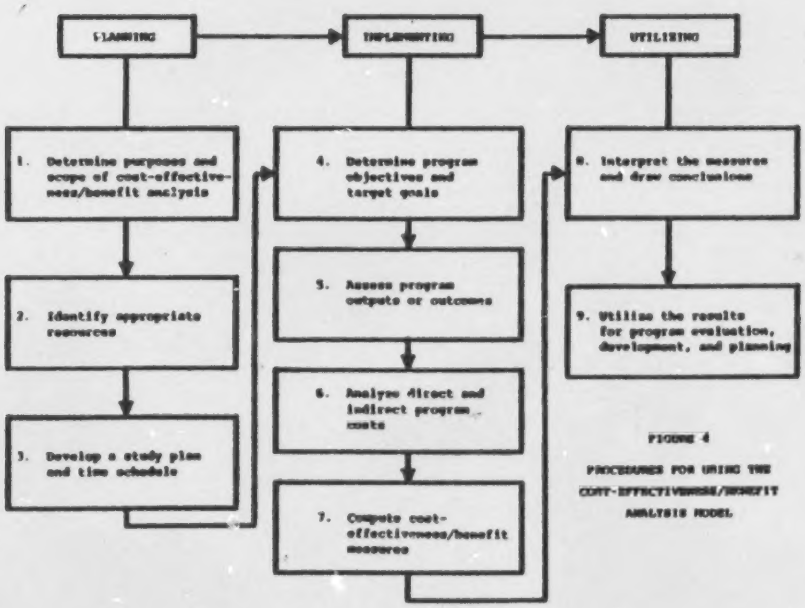

PLANNING
IMPLEMENTING
UTILIZING
1. Determine purposes and scope of cost-effectiveness/benefit analysis
2. Identify appropriate resources
3. Develop a study plan and time schedule
4. Determine program objectives and target goals
5. Assess program outputs or outcomes
6. Analyze direct and indirect program costs
7. Compute cost-effectiveness/benefit measures
8. Interpret the measures and draw conclusions
9. Utilize the results for program evaluation, development, and planning

FIGURE 4

PROCEDURES FOR USING THE COST-EFFECTIVENESS/BENEFIT ANALYSIS MODEL

Planning a Cost-Effectiveness/Benefit Analysis

The planning phase includes the determination of the purpose of a cost-effectiveness/benefit analysis, identification of appropriate resources, and development of a study plan.

Determination of the Analytical Purpose. The first step is to determine analytical purposes for using the model by identifying the reasons for conducting a cost-effectiveness/benefit analysis. It is necessary to anticipate what specific information will be required for specific decision situations, and what will be the scope of the analysis. Based upon the needed information and scope of the analysis, the analytical purposes are specified for improving program operation, providing information needed in decision-making, and/or improving public understanding and support for occupational programs. The identified needs, scope, and purposes are summarized into a request for a cost-effectiveness/benefit study.

Identification of Appropriate Resources. The next step in the planning phase is to identify personnel and fiscal resources required for implementing the analysis. A cost-effectiveness/benefit analysis requires a study team to conduct the analysis and an adequate staff to collect data. To make the analysis effective, key staff members who will need to use the cost-effectiveness/benefit analysis for making decisions should be involved on the study team and staff. An in-service workshop for such personnel can provide them with examples of how the analysis can be used. If it is necessary, an advisory committee can be organized and consultants can be invited from professional agencies to provide technical assistance. Available financial resources should be identified which can support the analysis on time and performance bases. The institutional administrators who will use the results of the cost-effectiveness/benefit analysis in their decision-making processes should allocate a budget for the implementation of the analysis.

Development of a Study Plan. After a study team is organized, the team develops a study plan which includes a design of the study, a time schedule, and a flow of procedural activities within that time. Because an analysis is addressed to certain decision situations, the reasons for the study and the information which it anticipates needing should be specified when the objectives of the study are defined. Data types and analytical forms which will be used to achieve the objectives should be described in the design. A time schedule for the study is made to include the procedural activities from start to completion of the study. Appropriate time should be allocated to data collection, analysis, interpretation, and writing a final report.

Implementing a Cost-Effectiveness/Benefit Analysis

As scheduled in the study plan, a cost-effectiveness/benefit analysis is implemented in a one-year period. The implementing phase

consists of a continuous process from the determination of target goals through computation of cost-effectiveness/benefit measures.

Determination of Target Goals. At the beginning of the school year, program objectives are determined in measurable terms as target goals. Considering the program characteristics, policy preferences, and data availability, a number of objectives and target goals can be selected from among the program objectives and target goal statements developed in the model. Then, administrators and teaching faculty cooperate to establish appropriate target goals for implementing the program. Also, these target goals can be used when making application for new programs.

Assessment of Program Outputs. The next step is to collect program output data which relate to program objectives. The actual output indicators are obtained from the analysis of student records and follow-up data pertaining to specific programs under study. Some data can be collected immediately upon completion of the program, whereas other long-range program output data will be available a few months or a few years later after completion. Additional data on student background and related community characteristics should be collected for use in interpreting the results of the analysis as well as in determining future target goals for the program.

Analysis of Program Costs. Directly related line items for the occupational program are identified and appropriate costs assigned to each of the items as direct costs. Expenditures for administrative and supporting services at departmental, school, or institutional level are prorated to the program on the basis of the number of full-time equivalent students or faculty members. The direct costs plus indirect support costs are accounted for as a total of program operation costs. If the study is concerned with a cost-benefit analysis, the opportunity cost for the time while students are studying at the postsecondary institution should be added to the program operation costs.

Computation of Cost-Effectiveness/Benefit Measures. After the data are collected, analytical formulas are applied to compute program effectiveness measures, cost efficiency measures, and a cost-effectiveness ratio and/or performance ratio. As previously discussed, program effectiveness scores are computed as measures of program goal attainments. Scores are combined into an effectiveness index. Cost internal efficiency is measured by computing unit cost per student, per student contact hour, or per completers or graduates. A performance efficiency index is made by the ratio of actual unit costs over budgeted or standardized unit costs of the program under study. Furthermore, an external efficiency index such as a cost-benefit ratio or a rate of return is drawn by comparing future incomes with program costs. Finally, a cost-effectiveness ratio is computed by dividing the program effectiveness index by the unit cost, and a performance ratio is determined by dividing the program effectiveness index by the performance efficiency index.

Utilizing the Results from the Analysis

After the analysis is finished, the measures are interpreted and reported to decision-makers so that they can use the results in decision-making.

Interpretation of the Measures. The resulting cost-effectiveness/benefit measures should be interpreted with careful consideration. Program effectiveness and cost efficiency measures are used to judge how effective and efficient the program is. A cost-effectiveness ratio can be considered as a criterion for judging program effectiveness in relation to the associated costs, and a performance ratio can be interpreted as the degree of program management performance. When interpreting measures, a deliberate effort should be made to check whether program objectives were appropriately selected, target goals were adequately determined, and what effectiveness index is most reliable to judge program effectiveness. In interpreting cost efficiency measures, the following points should be reviewed: (1) what budget items were involved in determining program costs, (2) how were costs assigned or prorated to the program, and (3) what efficiency measures are most reliable to judge whether the program is operated in an efficient way. In making a comparson of two or more programs, caution should be given to these additional points: (4) are effectiveness scores and index for all programs based on the same goal targets, (5) are efficiency measures and index for all programs based on the same cost items, and (6) are there common student characteristics in all programs.

Based on the interpretation of results, the study draws conclusions regarding effectiveness, efficiency, and performance of postsecondary occupational programs and develops recommendations for further actions which are reported to decision-makers.

Uses of Results and Recommendations. The analytical results, interpretation, and recommendations can be used for three purposes: (1) program evaluation, (2) program development, and (3) program planning.

For a program evaluation, cost-effectiveness/benefit measures provide criteria for determining: (1) how effective is the program or which program is most effective among the programs, (2) how efficient is the program or which program is most efficient among the programs, and (3) how well does the program perform or which program is most effective and efficient among the programs. It is possible to relate program effectiveness to costs by identifying factors which determine program costs and which influence program effectiveness.

The analytical results and conclusions provide decision-makers with information about needs for new program development. If the analysis identifies a program as ineffective and inefficient, a judgment can be made as to how the program should be modified or deleted or whether a new alternative program should be developed.

Finally, the cost-effectiveness/benefit analysis results form a planning base for the improvement of postsecondary occupational programs. Administrators can use the analysis to make a short-range (one or two-year) plan to increase program effectiveness and/or cost efficiency, and they can develop a long-range (five or ten year) plan for the comprehensive improvement of vocational programs from long-time perspectives.

Summary

Based upon the specified data types needed for a cost-effectiveness/benefit analysis, a set of data forms were developed for (1) determining program objectives and outputs, and (2) analyzing program costs. They are appended to this report (see Appendices B and C).

A standard procedure for using the cost-effectiveness/benefit model and data forms was conceptualized into nine steps within three phases: (1) planning a cost-effectiveness/benefit analysis, (2) implementing the analysis, and (3) utilizing the results from the analysis. The procedural scheme will provide a groundwork for developing a user-oriented manual to guide cost-effectiveness studies which will be conducted by vocational administrators.

CHAPTER V

EVALUATION OF PRODUCTS AND CONCLUSIONS

This final chapter discusses the uniqueness of the products, examines their usefulness, and presents the project's conclusions, recommendations, and suggestions for further studies.

Evaluation of the Products

A primary effort is made to evaluate the uniqueness and usefulness of the cost-effectiveness/benefit analysis model, data forms for determining program objectives and costs, and the cost-effectiveness/benefit measures.

Review of the Model

In developing a model for analyzing the cost-effectiveness of post-secondary vocational programs, the two concepts of cost-effectiveness analysis and cost-benefit analysis have been combined into one integrated form. Within the overall cost-effectiveness framework, cost-benefit measures are viewed as external efficiency measures which indicate the relationship between actual costs and completers' future earnings.

When the Project Advisory Committee reviewed the combined model it judged that, within its conceptual framework, the model is useful in measuring the cost-effectiveness and benefits of vocational programs as well as in identifying appropriate data for each component of the model. The committee further commented that, while the model is conceptually sound, the cost-benefit measures should be separated from the cost-effectiveness measures for practical use. The reason for this is that the cost-benefit technique might be difficult for practitioners to apply by themselves.

The Advisory Committee also refined program objectives and target goal statements into simple form for practitioner use and suggested that the program cost analysis scheme be made compatible with the Indiana Cost Information Study form (Commission for Higher Education, 1977).

Revision of Data Forms

A data form for determining program objectives and outputs has been developed for practitioners to put available data into a blanket form in accordance with the target goal statements. A data form for program cost

analysis has been made for practitioners to fill out figures and follow computing procedures on one simple form like an income tax return form. These data forms have been reviewed and accepted by the Advisory Committee.

Examination of Cost-Effectiveness/Benefit Measures

The cost-effectiveness/benefit model generates measures which provide evidence for analyzing vocational programs in terms of three primary questions: (1) Is the program effective, or to what extent have the program objectives been achieved? (2) How efficient is the program externally as well as internally? (3) Is the program operated in an effective and efficient manner? The cost-effectiveness and cost-benefit measures have been examined with hypothetical data to determine their usability. An example follows.

Suppose three occupational programs (A, B, and C) were selected for cost-effectiveness analysis from among the vocational programs in a two-year postsecondary institution. At the beginning of the school year, program objectives would be specified by three target goals of each program: (1) number of expected enrollment, (2) number of expected completers, and (3) percentage of expected employment. At the end of the year, program outputs would be identified by actual attainments of these target goals. Annual actual and budgeted costs would be analyzed for each program. These hypothetical data are as shown in Table II.

TABLE II

HYPOTHETICAL DATA FOR COST-EFFECTIVENESS ANALYSIS

Data Classification	*Occupational Programs*		
	A	B	C
1. Objectives: Target Goals			
a. # Expected Enrollment	40	40	40
b. # Expected Completers	20	20	20
c. % Expected Employment	80	95	85
2. Outputs: Actual Attainments			
a. # Actual Enrollment	31	32	30
b. # Actual Completers	16	18	14
c. % Actual Employment	70	85	72
3. Costs: Expended and Budgeted			
a. $ Total Expended Costs	32,000	41,400	27,300
b. $ Total Budgeted Costs	32,000	37,800	28,000

Based on these hypothetical data, cost-effectiveness measures are computed as follows:

1. Program effectiveness scores are computed by dividing outputs by target goals. Then each score was weighted according to its importance: 5 points for enrollment, 10 points for completion, and 15 points for employment.

2. Composite and average program effectiveness indices are made by adding the effectiveness scores and by dividing the composite index by the number of scores. Using the weighted scores, weighted composite and weighted average effectiveness indices are made in the same way.

3. Cost efficiency is measured by unit costs. Actual and budgeted unit costs per completer are computed by dividing total actual and budgeted costs by the total number of completers.

4. A cost efficiency index is computed by dividing actual total or unit costs by budgeted total or unit costs.

5. Finally, a cost effectiveness ratio is computed by dividing the weighted average effectiveness index by the actual unit cost. Then a performance ratio is computed by dividing the weighted average effectiveness index by the cost efficiency index.

The resulting cost-effectiveness measures for each occupational program appear in Table III. Referring to the program effectiveness index, program B has been indicated as the most effective among the three programs; whereas program C is the most efficient on the basis of the cost efficiency index. Furthermore, according to the performance ratio, program A appears the most effective and efficient among the three programs. Thus, these cost-effectiveness measures can be utilized as criteria for evaluating or comparing the degrees of effectiveness, efficiency, and performance among occupational programs.

In addition to these cost-effectiveness measures, cost-benefit measures can be computed by comparing the costs accrued by training in the program with future earnings after program completion. Student opportunity costs, which are accounted for by students' foregone income during the training periods, can be added to program costs. The total costs should be compared with the expected monetary benefits to compute cost-benefit measures. The assumptions and computing procedures are shown in Table IV and are described below.

TABLE III

COMPUTATION OF COST-EFFECTIVENESS MEASURES
USING HYPOTHETICAL DATA

Cost-Effectiveness Measures	*Occupational Programs*		
	A	B	C
1. Program Effectiveness Scores			
a. % Enrollment	77.5	80.0	75.0
b. % Completion	80.0	90.0	70.0
c. % Employment	87.5	89.5	84.7
(Weighted Effectiveness Scores)			
d. % Enrollment x 5	387.5	400.0	375.0
e. % Completion x 10	800.0	900.0	700.0
f. % Employment x 15	1312.5	1342.5	1270.5
2. Program Effectiveness Index			
a. Composite Index (1a + 1b + 1c)	245.0	259.5	229.7
b. Average Index (2a/3)	81.7	86.5	76.6
c. Weighted Composite Index (1d + 1e + 1f)	2500.0	2642.5	2345.5
d. Weighted Average Index (2c/30)	83.3	88.1	78.2
3. Cost Efficiency: Unit Cost			
a. $ Actual Unit Cost Per Completer	2,000	2,300	1,950
b. $ Expected Unit Cost Per Completer	2,000	2,100	2,000
4. Cost Efficiency Index			
a. Actual Unit Cost/Expected Unit Cost (%)	100.0	109.5	97.5
b. Actual Total Cost/Expected Total Cost (%)	100.0	109.5	97.5
5. C/E Ratio and Performance Ratio			
a. C/E Ratio (2d/3a)	.042	.038	.040
b. Performance Ratio (2d/4a)	.833	.804	.802

First, if student opportunity costs, which are being considered as foregone income, were $4,500 for a year, then student opportunity costs for a two-year training period would be $9,000. Total costs in the initial year period are estimated by adding the student opportunity costs to program costs for every program.

TABLE IV

COMPUTATION OF COST-BENEFIT MEASURES,
USING HYPOTHETICAL INFORMATION

Data Classification	*Occupational Programs*		
	A	B	C
1. Total Costs			
a. $ Program Cost Per Completer	2,000	2,300	1,950
b. $ Student Opportunity Cost (Foregone Income) Per Year	4,500	4,500	4,500
c. $ Student Opportunity Cost for Two-Year Training Period (1b x 2)	9,000	9,000	9,000
d. $ Total Cost at the Initial Period (1a + 1c)	11,000	11,300	10,950
2. Expected Monetary Benefits			
a. $ Post-Training Income for the First Year	6,000	6,200	5,800
b. $ Increased Income (2a - 1b)	1,500	1,700	1,300
c. % Annual Average Income Growth Rate	4	4	4
d. % Discounting or Interest Rate	6	6	6
e. # Working Periods (Years)	10	10	10
f. $ Sum of Present Value of Increased Incomes During 10 Year Period	13,005	14,650	11,271
3. Cost-Benefit Measures			
a. $ Net Present Value of Increased Income (2f - 1d)	2,005	3,350	321
b. Cost-Benefit Ratio (2f/1d)	1.182	1.296	1.029
c. % Internal Rate of Return	9.5	12.0	6.5

Second, if post-training incomes (average annual wages and salaries) for the first year are $6,000, $6,200, and $5,800 for programs A, B, and C, respectively, then increased incomes which are attributable to training are differentials from the post-training incomes less the one-year student foregone incomes. Suppose annual income growth rate is four percent (4%), discounting or interest rate is six percent (6%), and working periods

considered are ten years, then the sum of the expected present values of increased incomes during the ten-year periods can be estimated with Formula 7, using the $(1+k)^{t-1}$ and $(1+r)^{-t}$ tables in Appendix D.

Using the total costs and the expected present values of increased incomes, cost-benefit measures can be computed for each program. The net present values of increased incomes are estimated by subtracting the total costs from the sum of the present values of increased incomes (Formula 11); whereas the cost-benefit ratio is measured by dividing the latter by the former (Formula 12). The internal rates of return are measured by making the present value of increased incomes equal to the total costs according to Formula 13. The $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$ table can also be used to find the internal rate of return for the program by identifying the interest rate (r) at the given income growth rate (k=4). The interest rate can be found when the sum of the ratios of the growth rates divided by the discount rates is close to the ratio of costs divided by the increased income.

Based on the cost-benefit measures, the judgment about the cost efficiency of each program should be reconsidered. For instance, using the cost-benefit measures, program C is internally most efficient, but externally least efficient; whereas program B is internally least efficient, but externally most efficient. Program A still keeps a middle position between the two programs, thus, the cost-benefit measures can be used to evaluate programs from the long-term perspective after program completion and to make decisions about investments in occupational programs which are beneficial to the society in terms of their costs. Even though the cost-benefit measures are essential criteria for program evaluation, their computation and practical usefulness are "most decisively at the mercy of the availability of data" (Rothenberg, 1975, p. 88). The technique of cost-benefit analysis should be used with relevant data, thoughtful insights into social change, and appropriate formulas for computing the cost-benefit measures.

Conclusions and Recommendations

This report attempts to combine both the cost-effectiveness and cost-benefit analysis into a comprehensive framework, which is a cost-effectiveness/benefit analysis model for evaluating post-secondary vocational programs. The model specifies four major components and generates three kinds of cost-effectiveness/benefit measures. Data forms and standard procedures were developed for using the model. Through the advisory committee meeting, these products have been evaluated and refined to increase their usefulness for postsecondary vocational administrators and educators.

Conclusions

The following conclusions are drawn in light of their uniqueness and practical usefulness in analyzing cost-effectiveness/benefit of postsecondary vocational programs:

1. Cost-effectiveness/benefit analysis is defined as a technique for assessing outputs of existing and/or new programs in relation to their specified program objectives and measuring them against the costs of the programs. The analysis is viewed as a systems analysis technique, evaluation method, and planning tool. This operational definition, which is different from the commonly used one, provides a base for developing a cost-effectiveness/benefit analysis model.

2. The cost-effectiveness/benefit analysis model specifies four major components and generates three kinds of measures to provide answers to significant questions.

3. The set of program objectives and target goal statements and the program cost analysis scheme developed in the model can be useful for gathering management information.

4. Using the data forms, empirical data can be analyzed to determine cost-effectiveness/benefit measures as criteria for evaluating postsecondary vocational programs.

5. As a standard procedure for using the model, nine steps are conceptualized which correspond to the planning, implementing and utilizing phases. The procedural scheme will assist administrators in conducting cost-effectiveness/benefit analysis. Step-by-step activities are developed in the Administrator's Manual.

Recommendations

Although the products are concerned with the cost-effectiveness/benefit analysis of postsecondary vocational programs, their utilization can be extended to other areas, and they can be improved by cumulative research efforts. From this point of view, the following recommendations are made:

1. The basic conceptual scheme and technical procedures developed in the model can be

extended to the evaluation of any kinds of existing and/or alternative educational programs with appropriate specification of program objectives.

2. In determining program objectives and target goals, student and community characteristics information should be fully considered. The administrators and faculty should be involved in determining program target goals as well as in interpreting the results.

3. The three kinds of cost-effectiveness/benefit measures derived from the model should be used as evaluating criteria in the decision-making process, and the analysis should be continued as a recurrent process. Repeated analyses based on accumulated data will increase the utility of the results.

4. To facilitate the implementation of cost-effectiveness/benefit analysis, further consideration should be given to pilot studies, which demonstrate the use of this technique and to dissemination conferences, in which vocational administrators and other concerned people may participate.

5. Additional research will be needed for determining vocational program objectives and standardizing cost analysis. Based upon future research efforts, the model and products will be improved for more general use.

BIBLIOGRAPHY

Abt, C.C. Design for an Education System Cost-Effectiveness Model. In *Efficiency in Resource Utilization in Education*. Paris: Organization of Economic Cooperation and Development, 1969.

Banghart, F.W. *Educational Systems Analysis*. New York: Macmillan, 1969.

Benson, C.S. *The Economics of Public Education*. Boston: Houghton Mifflin, 1968.

Carpenter, M.B. & Haggart, S.A. Cost-Effectiveness Analysis for Educational Planning. *Educational Technology*, 1970 (October).

Cary, F.G. *Development of an Instructional Cost-Effectiveness Analysis Model for Use in School Districts*. Unpublished doctoral dissertation, State University of New York, 1972.

Clemmer, R. & others. *Indicators and Statewide Assessment*. Denver: Cooperative Accountability Project, March, 1974.

Correa, H. (Ed.). *Analytical Models in Educational Planning and Administration*. New York: David McKay, 1975.

Cross, A.A. Goals and Roles of Vocational Education. In M.E. Strong (Ed.), *Developing the Nation's Work Force* (Yearbook 5). Washington, D.C.: American Vocational Association, 1975.

Cross, K.P. *The Junior College Student: A Research Description*. Princeton: Educational Testing Services, 1968.

Evans, R.N. *Foundations of Vocational Education*. Columbus, Ohio: Charles E. Merrill, 1971.

Executive Office of the President, Office of Management & Budget. *Social Indicators: Selected Statistics in Social Conditions and Trends in the U.S.* Washington, D.C.: U.S. Gov't. Printing Office, 1973.

Forbes, R.H. Cost-Effectiveness Analysis: Primer and Guidelines. *Educational Technology*, 1974 (March) 21-27.

Gross, E. & Grambsch, P.V. *University Goals and Academic Power*. Washington, D.C.: American Council on Education, 1968.

Gulko, W.W. *Program Classification Structure* (Tech. Rep. No. 27). Boulder, Colo.: National Center for Higher Education Management Systems at Western Interstate Commission for Higher Education, 1972.

Hatry, H.P. & Cotton, J.F. *Program Planning for State, County, City*.

BIBLIOGRAPHY, *continued*

Washington, D.C.: George Washington University, 1967.

Indiana Commission for Higher Education. *Indiana Cost Information Study Guidelines: 1975-76*. Indianapolis: Commission for Higher Education, 1977.

Kaufman, J.J. *Cost-Effectiveness Analysis as a Method for the Evaluation of Vocational and Technical Education*. Paper presented at the meeting of the American Vocational Association, Dallas, December 1968 (ED 029983, VT 008586).

Kim, J.E. & Harris, R.C. *Cost-Effectiveness Analysis of Secondary Vocational Programs, Technical Report*. Bloomington: Indiana University, 1976.

Knezevich, S.J. *Administration of Public Education* (2nd ed.). New York: Harper and Row, 1969.

Knezevich, S.J. *Program Budgeting (PPBS)*. Berkeley: McCutchan, 1973.

Koch, J.V. *A Benefit-Cost Analysis of Vocational-Occupational Training at Selected Illinois Junior Colleges*. Springfield, Ill.: Illinois State Advisory Council on Vocational Education, 1972 (ED 079527).

Levin, H.M. Cost-Effectiveness Analysis in Evaluation Research. In M. Guttentag & E.L. Struening (Eds.). *Handbook of Evaluation Research* (Vol. 2). Beverly Hills, Calif.: SAGE, 1975.

Lyden, F.J. & Miller, E.G. (Eds.). *Planning Programming Budgeting: A Systems Approach to Management*. Chicago: Markham, 1968.

Mushkin, S. *Planning, Programming, Budgeting for City, State, County Objectives*. Washington, D.C.: George Washington University, 1967.

National Center for Educational Statistics. *Indicators of Educational Outcome, Fall 1972*. Washington, D.C.: Government Printing Office, 1973.

The Governor's Conference on Occupational Education. *Project 21*. Indianapolis: The State of Indiana, 1974.

Quade, E.S. Introduction and Overview. In T.A. Goldman (Ed.), *Cost-Effectiveness Analysis: New Approaches in Decision-Making*. New York: Frederick A. Praeger, 1967.

Richardson, W.B. *Cost-Benefit Analysis of Vocational-Technical Education Programs in Missouri Junior Colleges*. Unpublished doctoral dissertation, University of Missouri, 1972.

Riendeau, A.J. Trends in Postsecondary Vocational and Technical Education.

BIBLIOGRAPHY, *continued*

In M. Strong (Ed.), *Developing the Nation's Work Force*. Washington, D.C.: American Vocational Association, 1975.

Rossmiller, R.A. & Geske, T.G. Toward More Effective Use of School Resources. *Journal of Education Finance*, 1976, *1*, 484-502.

Rothenberg, J. Cost-Benefit Analysis: A Methodological Exposition. In E.L. Struening & M. Guttentag (Ed.), *Handbook of Evaluation Research*. Beverly Hills, Calif.: SAGE, 1975.

Schwarz, B. Introduction to Programme Budgeting and Cost-Effectiveness Analysis in Educational Planning. In *Budgeting, Programme Analysis and Cost-Effectiveness in Educational Planning*. Paris: Organization of Economic Cooperation and Development, 1968.

Sewell, S. *Conceptual Framework for Conducting Cost-Benefit Studies in Wisconsin Vocational, Technical, and Adult Education*. Fennimore, Wisc.: Southwest Wisconsin Vocational-Technical Institute, 1974 (VT 101380).

Sorenson, W. *A Proposed System for Predicting Costs of Vocational Education Programs in the California Community Colleges, Final Report*. Santa Clara, Calif.: West Valley Joint Community College District, 1972 (ED 073236).

Stromsdorfer, E.W. *Review and Synthesis of Cost-Effectiveness Studies of Vocational and Technical Education*. Columbus, Ohio: The Center for Vocational Education, August, 1972.

Struening, E.L. & Guttentag, M. (Ed.). *Handbook of Evaluation Research*. Beverly Hills, Calif.: SAGE, 1975.

U.S. Office of Education. *Financial Accounting: Classifications and Standard Terminology for Local and State School Systems, Handbook II*. (Rev. ed.). Washington, D.C.: U.S. Gov't. Printing Office, 1973.

U.S. Office of Education. *Vocational Education and Occupations*. Washington, D.C.: U.S. Government Printing Office, 1969.

Venn, G. *Man, Education, and Work: Postsecondary Vocational and Technical Education*. Washington, D.C.: American Council on Education, 1964.

Webb, R. *Conceptual Framework for Conducting Cost-Benefit Studies in Wisconsin Vocational, Technical, and Adult Education Programs*. Eau Claire, Wisc.: Wisconsin District One Technical Institute, 1974 (VT 101505).

Woodhall, M. *Cost-Benefit Analysis in Educational Planning*. Paris: International Institute of Educational Planning, 1970.

APPENDICES

		PAGE
Appendix A	OBJECTIVES AND TARGET GOAL STATEMENTS FOR THE POSTSECONDARY OCCUPATIONAL PROGRAMS . . .	48
Appendix B	DATA FORM FOR DETERMINING THE PROGRAM TARGET GOALS AND OUTPUTS	50
Appendix C	DATA FORM FOR PROGRAM COST ANALYSIS	54
Appendix D	TABLES FOR COMPUTING COST-BENEFIT MEASURES .	57

APPENDIX A — OBJECTIVES AND TARGET GOAL STATEMENTS FOR THE POSTSECONDARY OCCUPATIONAL PROGRAMS

OBJECTIVE 1. *Students will be enrolled in the postsecondary occupational program to meet their educational needs.* TARGET GOALS are:

1-a. ____ (a total number of) students will be enrolled in the occupational program.

1-b. ____ percent of the enrollments will include disadvantaged students.

1-c. ____ percent of the enrollments will include handicapped students.

1-d. ____ percent of male or female students will be enrolled in the program traditionally considered sex-stereotyped.

OBJECTIVE 2. *Students enrolled in the postsecondary occupational program will complete the requirements of the program and be prepared for career development.* TARGET GOALS are:

2-a. ____ percent of enrollments will receive available information and services for career preparation.

2-b. ____ percent of enrollments will complete the program requirements by passing appropriate occupational competency tests.

2-c. ____ percent of enrollments will receive a certificate or associate degree relating to the program.

2-d. ____ percent of enrollments will pass licensure examinations relating to the specific program.

OBJECTIVE 3. *Program completers will be placed according to their training in jobs which will meet manpower demands.* TARGET GOALS are:

3-a. ____ percent of completers having sought employment will be placed within six months after completing the program. (Consider military and apprenticeship as employed).

3-b. ____ percent of completers available for employment will be placed in their specialization in six months after completion.

3-c. ____ percent of completers available for employment will be placed in a job position as related to program in six months after completion.

APPENDIX A, *continued*

3-d. ____ percent of completers available for employment will find a job in six months after completion which meets manpower needs within the state.

3-e. ____ percent of completers available for employment will find a job in six months after completion to meet manpower needs outside the state.

3-f. ____ percent of employed completers will be rated as satisfactory in job skills by the employer.

3-g. ____ percent of employed completers will be rated as satisfactory in personal and social skills by the employer.

OBJECTIVE 4. *Some students will elect advanced studies after completion of the program.* TARGET GOALS are:

4-a. ____ percent of the graduates will be enrolled in advanced study programs.

4-b. ____ percent of the students enrolled in advanced study programs will be in an equivalent program specialty.

4-c. ____ percent of the students enrolled in advanced study programs will be in an allied program.

4-d. ____ percent of the students enrolled in advanced study programs will rate their previous program as helpful or a sound foundation to continue their advanced studies.

OBJECTIVE 5. *Program completers will increase their job satisfaction, status, and economic benefits.* TARGET GOALS are:

5-a. ____ percent of employed completers will report high job satisfaction.

5-b. ____ percent of employed completers will report salary increases related to previous training in the program.

5-c. ____ percent of employed completers will report job advancement related to the previous training in the program.

5-d. ____ increased earnings (net income) made by the individual will be related to the training in the programs.

5-e. ____ increased benefits (gross income) gained by the society will result from the training in the program.

APPENDIX B

DATA FORM FOR DETERMINING THE PROGRAM TARGET GOALS AND OUTPUTS

DATA UNIT

Program Objective	*Factor Unit*		*Basic Unit*		*Goal or Output*
1-a.	# of total enrollments				= ☐
1-b.	# of disadvantaged students ☐	÷	# of total enrollments ☐	x 100 =	☐ %
1-c.	# of handicapped students ☐	÷	# of total enrollments ☐	x 100 =	☐ %
1-d.	# of male or female students ☐	÷	# of total enrollments ☐	x 100 =	☐ %
2-a.	# of students who receive career information ☐	÷	# of total enrollments ☐	x 100 =	☐ %
2-b.	# of students who complete program requirements ☐	÷	# of total enrollments ☐	x 100 =	☐ %

APPENDIX B, *continued*

DATA UNIT

Program Objective	*Factor Unit*		*Basic Unit*		*Goal or Output*
2-c.	# of students who receive a degree	÷	# of total enrollments	x 100 =	%
2-d.	# of students who pass licensure examinations	÷	# of total enrollments	x 100 =	%
3-a.	# of completers employed	÷	# of completers available for employment	x 100 =	%
3-b.	# of completers placed in specialization	÷	# of completers available for employment	x 100 =	%
3-c.	# of completers placed in related jobs	÷	# of completers available for employment	x 100 =	%
3-d.	# of completers employed within state	÷	# of completers available for manpower needs	x 100 =	%
3-e.	# of completers employed outside the state	÷	# of completers available for manpower needs	x 100 =	%

APPENDIX B, *continued*

DATA UNIT

Program Objective	*Factor Unit*	*Basic Unit*	*Goal or Output*
3-f.	# of employed completers whose job skills satisfy employers	# of employed completers rated by employers	
	☐ ÷	☐ x 100 =	☐ %
3-g.	# of employed completers whose personal and social skills satisfy employers	# of employed completers rated by employers	
	☐ ÷	☐ x 100 =	☐ %
4-a.	# of completers enrolled in advanced studies	# of total completers	
	☐ ÷	☐ x 100 =	☐ %
4-b.	# of completers enrolled in a specialty equivalent to previous studies	# of completers enrolled in advanced studies	
	☐ ÷	☐ x 100 =	☐ %
4-c.	# of completers enrolled in a program allied to previous studies	# of completers enrolled in advanced studies	
	☐ ÷	☐ x 100 =	☐ %
4-d.	# of enrolled completers who rate the previous program as a sound foundation for advanced studies	# of completers enrolled in advanced studies	
	☐ ÷	☐ x 100 =	☐ %

APPENDIX B, *continued*

DATA UNIT

Program Objective	*Factor Unit*		*Basic Unit*		*Goal or Output*
5-a.	# of employed completers who report high job satisfaction		# of employed completers		
	☐	÷	☐	x 100 = ☐ %	
5-b.	# of employed completers who report salary increases related to previous training		# of employed completers		
	☐	÷	☐	x 100 = ☐ %	
5-c.	# of employed completers who report job advancement related to previous training		# of employed completers		
	☐	÷	☐	x 100 = ☐ %	
5-d.	Average of employed completers' earnings (net incomes)		Average of high school graduates' earnings (net incomes)		
	☐	-	☐	= $ ☐	
5-e.	Average of completers' earnings including taxes (gross income)		Average of high school graduates' earnings including taxes (gross income)		
	☐	-	☐	= $ ☐	

APPENDIX C DATA FORM FOR PROGRAM COST ANALYSIS

	Cost Item and Procedure	*Expected*	*Expended*
1.	Annual salary of teaching staff	$_____	$_____
2.	Fringe benefits for teaching staff	$_____	$_____
3.	Purchased services	$_____	$_____
4.	Instructional supplies and materials	$_____	$_____
5.	Instructional equipment (annually depreciated)	$_____	$_____
*6.	Instructional space use	$_____	$_____
	a. Total building space	_____ sq. ft.	
	b. Instructional space for the vocational program	_____ sq. ft.	
	c. % instructional space for the program (b÷a)	_____ %	
	d. % time in use for the vocational program	_____ %	
	e. Time/floor unit (c•d)	_____ %	
	f. Original building cost	$_____	
	g. Life expectancy	_____ years	
	h. Total annual depreciated cost (f÷g)	$_____	
	i. Annual depreciated cost for the program (c•h) •	$_____	
7.	Direct Costs - total (Adding 1-6)	$_____	$_____
8.	Departmental administration and support services - total	$_____	$_____
9.	% FTE students enrolled in the program	_____ %	
10.	Prorated departmental cost (8x9)	$_____	$_____

APPENDIX C, *continued*

Cost Item and Procedure	*Expected*	*Expended*
11. College administration and support services - total	$_____	$_____
12. % FTE faculty in the program	_____ %	
13. Prorated college level costs (11x12)	$_____	$_____
14. Institutional administration - total	$_____	$_____
15. Prorated institutional administration costs (14x12)	$_____	$_____
16. Library and student services - total	$_____	$_____
17. Prorated library and student service costs (16x9)	$_____	$_____
18. Plant operation and maintenance - total	$_____	$_____
19. Prorated plant operation and maintenance costs (18x6e)	$_____	$_____
20. Auxiliary services for faculty - total	$_____	$_____
21. Prorated faculty auxiliary costs (20x12)	$_____	$_____
22. Auxiliary services for student - total	$_____	$_____
23. Prorated student auxiliary cost (22x9)	$_____	$_____
24. Indirect Costs - total (10+13+15+17+19+21+23)	$_____	$_____
25. Total program costs (7+24)	$_____	$_____
26. Total number of FTE students enrolled in the program	_____	

APPENDIX C, *continued*

Cost Item and Procedure	*Expected*	*Expended*
27. Total number student credit hours in the program	_____	
28. Total number of program completers	_____	
29. Unit cost per student (25 ÷ 26)	$_____	$_____
30. Unit cost per student credit hour (25 ÷ 27)	$_____	$_____
31. Unit cost per completer (25 ÷ 28)	$_____	$_____

---

* Costs for instructional space use are optional when accounting for direct costs. When evaluating an individual program or comparing more than two programs within an institution, it may not be necessary to consider the capital outlays. However, if the analysis is directed to making decisions pertaining to comparison of vocational programs between institutions, or to selection of new programs which may need new space acquisitions, then captial costs must be considered.

APPENDIX D TABLES FOR COMPUTING COST-BENEFIT MEASURES

PAGE *APPENDIX*

58. . . . D-1 : TABLE FOR ANNUAL INCOME GROWTH RATES: $(1+k)^{t-1}$

59. . . . D-2 : TABLE FOR INTEREST RATES: $(1+r)^{t}$

60. . . . D-3 : TABLE FOR DISCOUNT RATES: $\frac{1}{(1+r)^{t}}$ or $(1+r)^{-t}$

61. . . . D-4 : TABLE OF CUMULATIVE SUM OF RATIOS OF INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=3

62. . . . D-5 : TABLE OF CUMULATIVE SUM OF RATIOS OF INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=4

63. . . . D-6 : TABLE OF CUMULATIVE SUM OF RATIOS OF INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=5

64. . . . D-7 : TABLE OF CUMULATIVE SUM OF RATIOS OF INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=6

APPENDIX D-1

TABLE FOR ANNUAL INCOME GROWTH RATES: $(1+k)^{t-1}$

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2.	1.0100	1.0200	1.0300	1.0400	1.0500	1.0600	1.0700	1.0800	1.0900	1.1000	1.1100	1.1200	1.1300	1.1400	1.1500
3.	1.0201	1.0404	1.0609	1.0816	1.1025	1.1236	1.1449	1.1664	1.1881	1.2100	1.2321	1.2544	1.2769	1.2996	1.3225
4.	1.0303	1.0612	1.0927	1.1249	1.1576	1.1910	1.2250	1.2597	1.2950	1.3310	1.3676	1.4049	1.4429	1.4815	1.5209
5.	1.0406	1.0824	1.1255	1.1699	1.2155	1.2625	1.3108	1.3605	1.4116	1.4641	1.5181	1.5735	1.6305	1.6890	1.7490
6.	1.0510	1.1041	1.1593	1.2167	1.2763	1.3382	1.4026	1.4693	1.5386	1.6105	1.6851	1.7623	1.8424	1.9254	2.0114
7.	1.0615	1.1262	1.1941	1.2653	1.3401	1.4185	1.5007	1.5869	1.6771	1.7716	1.8704	1.9738	2.0820	2.1950	2.3131
8.	1.0721	1.1487	1.2299	1.3159	1.4071	1.5036	1.6058	1.7138	1.8280	1.9487	2.0762	2.2107	2.3526	2.5023	2.6600
9.	1.0829	1.1717	1.2668	1.3686	1.4775	1.5938	1.7182	1.8509	1.9926	2.1436	2.3045	2.4760	2.6584	2.8526	3.0590
10.	1.0937	1.1951	1.3048	1.4233	1.5513	1.6895	1.8385	1.9990	2.1719	2.3579	2.5580	2.7731	3.0040	3.2519	3.5179
11.	1.1046	1.2190	1.3439	1.4802	1.6289	1.7908	1.9672	2.1589	2.3674	2.5937	2.8394	3.1058	3.3946	3.7072	4.0456
12.	1.1157	1.2434	1.3842	1.5395	1.7103	1.8983	2.1049	2.3316	2.5804	2.8531	3.1518	3.4785	3.8359	4.2262	4.6524
13.	1.1268	1.2682	1.4258	1.6010	1.7959	2.0122	2.2522	2.5182	2.8127	3.1384	3.4985	3.8960	4.3345	4.8179	5.3503
14.	1.1381	1.2936	1.4685	1.6651	1.8856	2.1329	2.4098	2.7196	3.0658	3.4523	3.8833	4.3635	4.8980	5.4924	6.1528
15.	1.1495	1.3195	1.5126	1.7317	1.9799	2.2609	2.5785	2.9372	3.3417	3.7975	4.3104	4.8871	5.5348	6.2613	7.0757
16.	1.1610	1.3459	1.5580	1.8009	2.0789	2.3966	2.7590	3.1722	3.6425	4.1772	4.7846	5.4736	6.2543	7.1379	8.1371
17.	1.1726	1.3728	1.6047	1.8730	2.1829	2.5404	2.9522	3.4259	3.9703	4.5950	5.3109	6.1304	7.0673	8.1372	9.3576
18.	1.1843	1.4002	1.6528	1.9479	2.2920	2.6928	3.1588	3.7000	4.3276	5.0545	5.8951	6.8660	7.9861	9.2765	10.7613
19.	1.1961	1.4282	1.7024	2.0258	2.4066	2.8543	3.3799	3.9960	4.7171	5.5599	6.5436	7.6900	9.0243	10.5752	12.3755
20.	1.2081	1.4568	1.7535	2.1068	2.5270	3.0256	3.6165	4.3157	5.1417	6.1159	7.2633	8.6128	10.1974	12.0557	14.2318
21.	1.2202	1.4859	1.8061	2.1911	2.6533	3.2071	3.8697	4.6610	5.6044	6.7275	8.0623	9.6463	11.5231	13.7435	16.3665
22.	1.2324	1.5157	1.8603	2.2788	2.7860	3.3996	4.1406	5.0338	6.1088	7.4002	8.9492	10.8038	13.0211	15.6676	18.8215
23.	1.2447	1.5460	1.9161	2.3699	2.9253	3.6035	4.4304	5.4365	6.6586	8.1403	9.9336	12.1003	14.7138	17.8610	21.6447
24.	1.2572	1.5769	1.9736	2.4647	3.0715	3.8197	4.7405	5.8715	7.2579	8.9543	11.0263	13.5523	16.6266	20.3616	24.8915
25.	1.2697	1.6084	2.0328	2.5633	3.2251	4.0489	5.0724	6.3412	7.9111	9.8497	12.2392	15.1786	18.7881	23.2122	28.6252
26.	1.2824	1.6406	2.0938	2.6658	3.3864	4.2919	5.4274	6.8485	8.6231	10.8347	13.5855	17.0001	21.2305	26.4619	32.9190
27.	1.2953	1.6734	2.1566	2.7725	3.5557	4.5494	5.8074	7.3964	9.3992	11.9182	15.0799	19.0401	23.9905	30.1666	37.8568
28.	1.3082	1.7069	2.2213	2.8834	3.7335	4.8223	6.2139	7.9881	10.2451	13.1100	16.7386	21.3249	27.1093	34.3899	43.5353
29.	1.3213	1.7410	2.2879	2.9987	3.9201	5.1117	6.6488	8.6271	11.1671	14.4210	18.5799	23.8839	30.6335	39.2045	50.0656
30.	1.3345	1.7756	2.3566	3.1187	4.1161	5.4184	7.1143	9.3173	12.1722	15.8631	20.6237	26.7499	34.6158	44.6931	57.5755
31.	1.3478	1.8114	2.4273	3.2434	4.3219	5.7435	7.6123	10.0627	13.2677	17.4494	22.8923	29.9599	39.1159	50.9502	66.2118
32.	1.3613	1.8476	2.5001	3.3731	4.5380	6.0881	8.1451	10.8677	14.4618	19.1943	25.4104	33.5551	44.2010	58.0832	76.1435
33.	1.3749	1.8845	2.5751	3.5081	4.7649	6.4534	8.7153	11.7371	15.7633	21.1138	28.2056	37.5817	49.9471	66.2148	87.5651
34.	1.3887	1.9222	2.6523	3.6484	5.0032	6.8406	9.3253	12.6760	17.1820	23.2252	31.3082	42.0915	56.4402	75.4849	100.6998
35.	1.4026	1.9607	2.7319	3.7943	5.2533	7.2510	9.9781	13.6901	18.7284	25.5477	34.7521	47.1425	63.7774	86.0528	115.8048
36.	1.4166	1.9999	2.8139	3.9461	5.5160	7.6861	10.6766	14.7853	20.4140	28.1024	38.5749	52.7996	72.0685	98.1002	133.1755
37.	1.4308	2.0399	2.8983	4.1039	5.7918	8.1473	11.4239	15.9682	22.2512	30.9127	42.8181	59.1356	81.4374	111.8342	153.1519
38.	1.4451	2.0807	2.9852	4.2681	6.0814	8.6361	12.2236	17.2456	24.2538	34.0039	47.5281	66.2318	92.0243	127.4910	176.1246
39.	1.4595	2.1223	3.0748	4.4388	6.3855	9.1543	13.0793	18.6253	26.4367	37.4043	52.7562	74.1797	103.9874	145.3397	202.5433
40.	1.4741	2.1647	3.1670	4.6164	6.7048	9.7035	13.9948	20.1153	28.8160	41.1448	58.5593	83.0812	117.6058	165.6873	232.9248

BEST COPY AVAILABLE

APPENDIX D-2

TABLE FOR INTEREST RATES: $(1+r)^t$

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	1.0100	1.0200	1.0300	1.0400	1.0500	1.0600	1.0700	1.0800	1.0900	1.1000	1.1100	1.1200	1.1300	1.1400	1.1500
2.	1.0201	1.0404	1.0609	1.0816	1.1025	1.1236	1.1449	1.1664	1.1881	1.2100	1.2321	1.2544	1.2769	1.2996	1.3225
3.	1.0303	1.0612	1.0927	1.1249	1.1576	1.1910	1.2250	1.2597	1.2950	1.3310	1.3676	1.4049	1.4429	1.4815	1.5209
4.	1.0406	1.0824	1.1255	1.1699	1.2155	1.2625	1.3108	1.3605	1.4116	1.4641	1.5181	1.5735	1.6305	1.6890	1.7490
5.	1.0510	1.1041	1.1593	1.2167	1.2763	1.3382	1.4026	1.4693	1.5386	1.6105	1.6851	1.7623	1.8424	1.9254	2.0114
6.	1.0615	1.1262	1.1941	1.2653	1.3401	1.4185	1.5007	1.5869	1.6771	1.7716	1.8704	1.9738	2.0820	2.1950	2.3131
7.	1.0721	1.1487	1.2299	1.3159	1.4071	1.5036	1.6058	1.7138	1.8280	1.9487	2.0762	2.2107	2.3526	2.5023	2.6600
8.	1.0829	1.1717	1.2668	1.3686	1.4775	1.5938	1.7182	1.8509	1.9926	2.1436	2.3045	2.4760	2.6584	2.8526	3.0590
9.	1.0937	1.1951	1.3048	1.4233	1.5513	1.6895	1.8385	1.9990	2.1719	2.3579	2.5580	2.7731	3.0040	3.2519	3.5179
10.	1.1046	1.2190	1.3439	1.4802	1.6289	1.7908	1.9672	2.1589	2.3674	2.5937	2.8394	3.1058	3.3946	3.7072	4.0456
11.	1.1157	1.2434	1.3842	1.5395	1.7103	1.8983	2.1049	2.3316	2.5804	2.8531	3.1518	3.4785	3.8359	4.2262	4.6524
12.	1.1268	1.2682	1.4258	1.6010	1.7959	2.0122	2.2522	2.5182	2.8127	3.1384	3.4985	3.8960	4.3345	4.8179	5.3503
13.	1.1381	1.2936	1.4685	1.6651	1.8856	2.1329	2.4098	2.7196	3.0658	3.4523	3.8833	4.3635	4.8980	5.4924	6.1528
14.	1.1498	1.3195	1.5126	1.7317	1.9799	2.2609	2.5785	2.9372	3.3417	3.7975	4.3104	4.8871	5.5348	6.2613	7.0757
15.	1.1610	1.3459	1.5580	1.8009	2.0789	2.3966	2.7590	3.1722	3.6425	4.1772	4.7846	5.4736	6.2543	7.1379	8.1371
16.	1.1726	1.3728	1.6047	1.8730	2.1829	2.5404	2.9522	3.4259	3.9703	4.5950	5.3109	6.1304	7.0673	8.1372	9.3576
17.	1.1843	1.4002	1.6528	1.9479	2.2920	2.6928	3.1588	3.7000	4.3276	5.0545	5.8951	6.8660	7.9861	9.2765	10.7613
18.	1.1961	1.4282	1.7024	2.0258	2.4066	2.8543	3.3799	3.9960	4.7171	5.5599	6.5436	7.6900	9.0243	10.5752	12.3755
19.	1.2081	1.4568	1.7535	2.1068	2.5270	3.0256	3.6165	4.3157	5.1417	6.1159	7.2633	8.6128	10.1974	12.0557	14.2318
20.	1.2202	1.4859	1.8061	2.1911	2.6533	3.2071	3.8697	4.6610	5.6044	6.7275	8.0623	9.6463	11.5231	13.7435	16.3665
21.	1.2324	1.5157	1.8603	2.2788	2.7860	3.3996	4.1406	5.0338	6.1088	7.4002	8.9492	10.8038	13.0211	15.6676	18.8215
22.	1.2447	1.5460	1.9161	2.3699	2.9253	3.6035	4.4304	5.4365	6.6586	8.1403	9.9336	12.1003	14.7138	17.8610	21.6447
23.	1.2572	1.5769	1.9736	2.4647	3.0715	3.8197	4.7405	5.8715	7.2579	8.9543	11.0263	13.5523	16.6266	20.3616	24.8915
24.	1.2697	1.6084	2.0328	2.5633	3.2251	4.0489	5.0724	6.3412	7.9111	9.8497	12.2392	15.1786	18.7881	23.2122	28.6252
25.	1.2824	1.6406	2.0938	2.6658	3.3864	4.2919	5.4274	6.8485	8.6231	10.8347	13.5855	17.0001	21.2305	26.4619	32.9190
26.	1.2953	1.6734	2.1566	2.7725	3.5557	4.5494	5.8074	7.3964	9.3992	11.9182	15.0799	19.0401	23.9905	30.1666	37.8568
27.	1.3082	1.7069	2.2213	2.8834	3.7335	4.8223	6.2139	7.9881	10.2451	13.1100	16.7386	21.3249	27.1093	34.3899	43.5353
28.	1.3213	1.7410	2.2879	2.9987	3.9201	5.1117	6.6488	8.6271	11.1671	14.4210	18.5799	23.8839	30.6335	39.2045	50.0656
29.	1.3345	1.7758	2.3566	3.1187	4.1161	5.4184	7.1143	9.3173	12.1722	15.8631	20.6237	26.7499	34.6158	44.6931	57.5755
30.	1.3478	1.8114	2.4273	3.2434	4.3219	5.7435	7.6123	10.0627	13.2677	17.4494	22.8923	29.9599	39.1159	50.9502	66.2118
31.	1.3613	1.8476	2.5001	3.3731	4.5380	6.0881	8.1451	10.8677	14.4618	19.1943	25.4104	33.5551	44.2010	58.0832	76.1435
32.	1.3749	1.8845	2.5751	3.5081	4.7649	6.4534	8.7153	11.7371	15.7633	21.1138	28.2056	37.5817	49.9471	66.2148	87.5651
33.	1.3887	1.9222	2.6523	3.6484	5.0032	6.8406	9.3253	12.6760	17.1820	23.2252	31.3082	42.0915	56.4402	75.4849	100.6998
34.	1.4026	1.9607	2.7319	3.7943	5.2533	7.2510	9.9781	13.6901	18.7284	25.5477	34.7521	47.1425	63.7774	86.0528	115.8048
35.	1.4166	1.9999	2.8139	3.9461	5.5160	7.6861	10.6766	14.7853	20.4140	28.1024	38.5749	52.7996	72.0685	98.1002	133.1755
36.	1.4308	2.0399	2.8983	4.1039	5.7918	8.1473	11.4239	15.9682	22.2512	30.9127	42.8181	59.1356	81.4374	111.8342	153.1519
37.	1.4451	2.0807	2.9852	4.2681	6.0814	8.6361	12.2236	17.2456	24.2538	34.0039	47.5281	66.2318	92.0243	127.4910	176.1246
38.	1.4595	2.1223	3.0748	4.4388	6.3855	9.1543	13.0793	18.6253	26.4367	37.4043	52.7562	74.1797	103.9874	145.3397	202.5433
39.	1.4741	2.1647	3.1670	4.6164	6.7048	9.7035	13.9948	20.1153	28.8160	41.1448	58.5593	83.0812	117.5058	165.6873	232.9248
40.	1.4889	2.2080	3.2620	4.8010	7.0400	10.2857	14.9745	21.7245	31.4094	45.2593	65.0009	93.0510	132.7816	188.8835	267.8635

BEST COPY AVAILABLE

APPENDIX D-3

TABLE FOR DISCOUNT RATES: $\frac{1}{(1+r)^t}$ or $(1+r)^{-t}$

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	.9901	.9804	.9709	.9615	.9524	.9434	.9346	.9259	.9174	.9091	.9009	.8929	.8850	.8772	.8696
2.	.9803	.9612	.9426	.9246	.9070	.8900	.8734	.8573	.8417	.8264	.8116	.7972	.7831	.7695	.7561
3.	.9706	.9423	.9151	.8890	.8638	.8396	.8163	.7938	.7722	.7513	.7312	.7118	.6931	.6750	.6575
4.	.9610	.9238	.8885	.8548	.8227	.7921	.7629	.7350	.7084	.6830	.6587	.6355	.6133	.5921	.5718
5.	.9515	.9057	.8626	.8219	.7835	.7473	.7130	.6806	.6499	.6209	.5935	.5674	.5428	.5194	.4972
6.	.9420	.8880	.8375	.7903	.7462	.7050	.6663	.6302	.5963	.5645	.5346	.5066	.4803	.4556	.4323
7.	.9327	.8706	.8131	.7599	.7107	.6651	.6227	.5835	.5470	.5132	.4817	.4523	.4251	.3996	.3759
8.	.9235	.8535	.7894	.7307	.6768	.6274	.5820	.5403	.5019	.4665	.4339	.4039	.3762	.3506	.3269
9.	.9143	.8368	.7664	.7026	.6446	.5919	.5439	.5002	.4604	.4241	.3909	.3606	.3329	.3075	.2843
10.	.9053	.8203	.7441	.6756	.6139	.5584	.5083	.4632	.4224	.3855	.3522	.3220	.2946	.2697	.2472
11.	.8963	.8043	.7224	.6496	.5847	.5268	.4751	.4289	.3875	.3505	.3173	.2875	.2607	.2366	.2149
12.	.8874	.7885	.7014	.6246	.5568	.4970	.4440	.3971	.3555	.3186	.2858	.2567	.2307	.2076	.1869
13.	.8787	.7730	.6810	.6006	.5303	.4688	.4150	.3677	.3262	.2897	.2575	.2292	.2042	.1821	.1625
14.	.8700	.7579	.6611	.5775	.5051	.4423	.3878	.3405	.2992	.2633	.2320	.2046	.1807	.1597	.1413
15.	.8613	.7430	.6419	.5553	.4810	.4173	.3624	.3152	.2745	.2394	.2090	.1827	.1599	.1401	.1229
16.	.8528	.7284	.6232	.5339	.4581	.3936	.3387	.2919	.2519	.2176	.1883	.1631	.1415	.1229	.1069
17.	.8444	.7142	.6050	.5134	.4363	.3714	.3166	.2703	.2311	.1978	.1696	.1456	.1252	.1078	.0929
18.	.8360	.7002	.5874	.4936	.4155	.3503	.2959	.2502	.2120	.1799	.1528	.1300	.1108	.0946	.0808
19.	.8277	.6864	.5703	.4746	.3957	.3305	.2765	.2317	.1945	.1635	.1377	.1161	.0981	.0829	.0703
20.	.8195	.6730	.5537	.4564	.3769	.3118	.2584	.2145	.1784	.1486	.1240	.1037	.0868	.0728	.0611
21.	.8114	.6598	.5375	.4388	.3589	.2942	.2415	.1987	.1637	.1351	.1117	.0926	.0768	.0638	.0531
22.	.8034	.6468	.5219	.4220	.3418	.2775	.2257	.1839	.1502	.1228	.1007	.0826	.0680	.0560	.0462
23.	.7954	.6342	.5067	.4057	.3256	.2618	.2109	.1703	.1378	.1117	.0907	.0738	.0601	.0491	.0402
24.	.7876	.6217	.4919	.3901	.3101	.2470	.1971	.1577	.1264	.1015	.0817	.0659	.0532	.0431	.0349
25.	.7798	.6095	.4776	.3751	.2953	.2330	.1842	.1460	.1160	.0923	.0736	.0588	.0471	.0378	.0304
26.	.7720	.5976	.4637	.3607	.2812	.2198	.1722	.1352	.1064	.0839	.0663	.0525	.0417	.0331	.0264
27.	.7644	.5859	.4502	.3468	.2678	.2074	.1609	.1252	.0976	.0763	.0597	.0469	.0369	.0291	.0230
28.	.7568	.5744	.4371	.3335	.2551	.1956	.1504	.1159	.0895	.0693	.0538	.0419	.0326	.0255	.0200
29.	.7493	.5631	.4243	.3207	.2429	.1846	.1406	.1073	.0822	.0630	.0485	.0374	.0289	.0224	.0174
30.	.7419	.5521	.4120	.3083	.2314	.1741	.1314	.0994	.0754	.0573	.0437	.0334	.0256	.0196	.0151
31.	.7346	.5412	.4000	.2965	.2204	.1643	.1228	.0920	.0691	.0521	.0394	.0298	.0226	.0172	.0131
32.	.7273	.5306	.3883	.2851	.2099	.1550	.1147	.0852	.0634	.0474	.0355	.0266	.0200	.0151	.0114
33.	.7201	.5202	.3770	.2741	.1999	.1462	.1072	.0789	.0582	.0431	.0319	.0238	.0177	.0132	.0099
34.	.7130	.5100	.3660	.2636	.1904	.1379	.1002	.0730	.0534	.0391	.0288	.0212	.0157	.0116	.0086
35.	.7059	.5000	.3554	.2534	.1813	.1301	.0937	.0676	.0490	.0356	.0259	.0189	.0139	.0102	.0075
36.	.6989	.4902	.3450	.2437	.1727	.1227	.0875	.0626	.0449	.0323	.0234	.0169	.0123	.0089	.0065
37.	.6920	.4806	.3350	.2343	.1644	.1158	.0818	.0580	.0412	.0294	.0210	.0151	.0109	.0078	.0057
38.	.6852	.4712	.3252	.2253	.1566	.1092	.0765	.0537	.0378	.0267	.0190	.0135	.0096	.0069	.0049
39.	.6784	.4619	.3158	.2166	.1491	.1031	.0715	.0497	.0347	.0243	.0171	.0120	.0085	.0060	.0043
40.	.6717	.4529	.3066	.2083	.1420	.0972	.0668	.0460	.0318	.0221	.0154	.0107	.0075	.0053	.0037

BEST COPY AVAILABLE

APPENDIX D-4

TABLE OF CUMULATIVE SUM OF RATIOS OF

INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=3

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	.990	.980	.971	.962	.952	.943	.935	.926	.917	.909	.901	.893	.885	.877	.870
2.	2.000	1.970	1.942	1.914	1.887	1.860	1.834	1.809	1.784	1.760	1.737	1.714	1.692	1.670	1.648
3.	3.030	2.970	2.913	2.857	2.803	2.751	2.700	2.651	2.604	2.557	2.513	2.469	2.427	2.386	2.346
4.	4.080	3.980	3.883	3.791	3.702	3.616	3.534	3.454	3.378	3.304	3.232	3.164	3.097	3.033	2.971
5.	5.150	4.999	4.854	4.716	4.584	4.457	4.336	4.220	4.109	4.003	3.900	3.802	3.708	3.617	3.530
6.	6.243	6.028	5.825	5.632	5.449	5.275	5.109	4.951	4.800	4.657	4.520	4.390	4.265	4.146	4.031
7.	7.356	7.068	6.796	6.540	6.298	6.069	5.852	5.648	5.454	5.270	5.095	4.930	4.772	4.623	4.480
8.	8.492	8.118	7.767	7.438	7.130	6.840	6.568	6.312	6.071	5.843	5.629	5.426	5.235	5.054	4.882
9.	9.650	9.178	8.738	8.328	7.947	7.590	7.257	6.946	6.654	6.381	6.124	5.883	5.657	5.443	5.243
10.	10.831	10.248	9.709	9.210	8.748	8.319	7.921	7.550	7.205	6.884	6.584	6.303	6.041	5.795	5.565
11.	12.036	11.329	10.680	10.085	9.533	9.027	8.559	8.127	7.726	7.355	7.010	6.690	6.391	6.113	5.854
12.	13.265	12.420	11.650	10.947	10.304	9.715	9.174	8.676	8.218	7.796	7.406	7.045	6.711	6.401	6.113
13.	14.517	13.522	12.621	11.804	11.060	10.383	9.765	9.200	8.683	8.209	7.773	7.372	7.002	6.660	6.344
14.	15.795	14.635	13.598	12.652	11.802	11.033	10.335	9.700	9.123	8.596	8.114	7.672	7.267	6.895	6.552
15.	17.098	15.759	14.563	13.492	12.530	11.664	10.885	10.177	9.538	8.958	8.430	7.949	7.509	7.107	6.738
16.	18.426	16.894	15.534	14.323	13.243	12.277	11.411	10.632	9.930	9.297	8.723	8.203	7.729	7.298	6.904
17.	19.781	18.040	16.505	15.147	13.943	12.873	11.919	11.066	10.301	9.614	8.995	8.436	7.930	7.471	7.053
18.	21.163	19.197	17.476	15.963	14.630	13.452	12.408	11.479	10.652	9.911	9.248	8.651	8.113	7.627	7.187
19.	22.572	20.366	18.447	16.771	15.304	14.015	12.879	11.874	10.983	10.190	9.482	8.849	8.280	7.769	7.307
20.	24.009	21.546	19.417	17.571	15.965	14.562	13.332	12.250	11.296	10.450	9.700	9.031	8.433	7.896	7.414
21.	25.475	22.738	20.388	18.364	16.613	15.093	13.768	12.609	11.591	10.695	9.902	9.198	8.571	8.011	7.510
22.	26.970	23.941	21.359	19.149	17.249	15.609	14.188	12.951	11.871	10.923	10.089	9.352	8.698	8.116	7.596
23.	28.494	25.156	22.330	19.926	17.873	16.111	14.592	13.277	12.135	11.137	10.263	9.493	8.813	8.210	7.673
24.	30.048	26.383	23.301	20.696	18.485	16.598	14.981	13.589	12.384	11.337	10.424	9.623	8.918	8.295	7.742
25.	31.633	27.622	24.272	21.459	19.085	17.072	15.356	13.885	12.620	11.525	10.574	9.743	9.014	8.372	7.803
26.	33.250	28.873	25.243	22.214	19.674	17.532	15.716	14.169	12.843	11.701	10.712	9.853	9.101	8.441	7.859
27.	34.898	30.137	26.214	22.962	20.252	17.979	16.063	14.438	13.053	11.865	10.841	9.954	9.181	8.504	7.908
28.	36.579	31.413	27.184	23.703	20.818	18.414	16.397	14.696	13.252	12.019	10.961	10.047	9.253	8.560	7.953
29.	38.294	32.701	28.155	24.436	21.374	18.836	16.719	14.942	13.440	12.163	11.072	10.132	9.319	8.612	7.992
30.	40.042	34.002	29.126	25.163	21.919	19.246	17.028	15.176	13.618	12.299	11.175	10.211	9.379	8.658	8.028
31.	41.825	35.316	30.097	25.883	22.454	19.645	17.326	15.399	13.785	12.425	11.270	10.283	9.434	8.700	8.060
32.	43.643	36.642	31.068	26.595	22.979	20.032	17.613	15.612	13.944	12.543	11.359	10.350	9.484	8.737	8.088
33.	45.498	37.982	32.039	27.301	23.494	20.409	17.889	15.815	14.094	12.654	11.441	10.411	9.530	8.771	8.114
34.	47.389	39.335	33.010	28.000	23.998	20.775	18.155	16.009	14.236	12.758	11.517	10.467	9.572	8.802	8.137
35.	49.317	40.701	33.981	28.692	24.494	21.130	18.411	16.194	14.369	12.855	11.588	10.519	9.610	8.830	8.157
36.	51.284	42.080	34.951	29.378	24.980	21.475	18.657	16.370	14.496	12.946	11.654	10.567	9.644	8.855	8.176
37.	53.290	43.473	35.922	30.057	25.456	21.811	18.895	16.538	14.615	13.032	11.715	10.610	9.676	8.878	8.192
38.	55.335	44.880	36.893	30.730	25.924	22.137	19.123	16.698	14.728	13.111	11.771	10.651	9.704	8.899	8.207
39.	57.421	46.300	37.864	31.396	26.382	22.454	19.343	16.851	14.835	13.186	11.824	10.688	9.730	8.917	8.220
40.	59.548	47.735	38.835	32.055	26.832	22.762	19.554	16.997	14.936	13.256	11.873	10.722	9.754	8.934	8.232

BEST COPY AVAILABLE

APPENDIX D-5

TABLE OF CUMULATIVE SUM OF RATIOS OF

INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=4

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	.990	.980	.971	.962	.952	.943	.935	.926	.917	.909	.901	.893	.885	.877	.870
2.	2.010	1.980	1.951	1.923	1.896	1.869	1.843	1.818	1.793	1.769	1.745	1.722	1.699	1.677	1.656
3.	3.059	2.999	2.941	2.885	2.830	2.777	2.726	2.676	2.628	2.581	2.536	2.492	2.449	2.407	2.367
4.	4.140	4.038	3.940	3.846	3.755	3.668	3.584	3.503	3.425	3.350	3.277	3.207	3.139	3.073	3.010
5.	5.253	5.098	4.950	4.808	4.672	4.542	4.418	4.299	4.185	4.076	3.971	3.870	3.774	3.681	3.592
6.	6.400	6.178	5.968	5.769	5.580	5.400	5.229	5.066	4.911	4.763	4.622	4.487	4.358	4.235	4.118
7.	7.580	7.280	6.997	6.731	6.479	6.242	6.017	5.804	5.603	5.412	5.231	5.059	4.896	4.741	4.594
8.	8.795	8.403	8.036	7.692	7.370	7.067	6.783	6.515	6.263	6.026	5.802	5.591	5.391	5.202	5.024
9.	10.046	9.548	9.085	8.654	8.252	7.877	7.527	7.200	6.893	6.606	6.337	6.084	5.847	5.623	5.413
10.	11.335	10.716	10.144	9.615	9.126	8.672	8.251	7.859	7.495	7.155	6.838	6.543	6.266	6.007	5.765
11.	12.662	11.906	11.213	10.577	9.991	9.452	8.954	8.494	8.068	7.674	7.308	6.968	6.652	6.357	6.083
12.	14.028	13.120	12.293	11.538	10.849	10.217	9.637	9.105	8.616	8.164	7.748	7.363	7.007	6.677	6.371
13.	15.435	14.358	13.383	12.500	11.698	10.967	10.302	9.694	9.138	8.628	8.160	7.730	7.334	6.968	6.651
14.	16.883	15.620	14.484	13.462	12.539	11.704	10.948	10.261	9.636	9.067	8.547	8.071	7.635	7.234	6.866
15.	18.375	16.906	15.596	14.423	13.372	12.426	11.575	10.807	10.111	9.481	8.908	8.387	7.912	7.477	7.079
16.	19.911	18.218	16.718	15.385	14.197	13.135	12.185	11.332	10.565	9.873	9.248	8.681	8.166	7.698	7.271
17.	21.492	19.556	17.851	16.346	15.014	13.831	12.778	11.839	10.998	10.244	9.565	8.954	8.401	7.900	7.445
18.	23.121	20.920	18.995	17.308	15.823	14.513	13.359	12.326	11.411	10.594	9.863	9.207	8.617	8.084	7.603
19.	24.797	22.310	20.151	18.269	16.625	15.183	13.915	12.795	11.805	10.925	10.142	9.442	8.815	8.252	7.745
20.	26.524	23.728	21.317	19.231	17.419	15.840	14.459	13.247	12.181	11.238	10.403	9.661	8.998	8.406	7.874
21.	28.302	25.174	22.495	20.192	18.205	16.484	14.988	13.683	12.539	11.534	10.648	9.863	9.167	8.546	7.990
22.	30.133	26.648	23.684	21.154	18.984	17.117	15.503	14.102	12.882	11.814	10.877	10.052	9.321	8.673	8.096
23.	32.018	28.151	24.885	22.115	19.756	17.737	16.003	14.506	13.208	12.079	11.092	10.227	9.464	8.790	8.191
24.	33.959	29.683	26.098	23.077	20.520	18.346	16.488	14.894	13.520	12.329	11.294	10.389	9.595	8.896	8.277
25.	35.958	31.245	27.322	24.038	21.277	18.943	16.961	15.269	13.817	12.566	11.482	10.540	9.716	8.993	8.355
26.	38.016	32.839	28.558	25.000	22.027	19.529	17.420	15.629	14.101	12.790	11.659	10.680	9.827	9.081	8.425
27.	40.135	34.463	29.806	25.962	22.769	20.104	17.866	15.976	14.371	13.001	11.825	10.810	9.929	9.162	8.489
28.	42.318	36.119	31.066	26.923	23.505	20.668	18.300	16.310	14.629	13.201	11.980	10.931	10.023	9.235	8.546
29.	44.565	37.808	32.339	27.885	24.234	21.222	18.721	16.632	14.876	13.390	12.125	11.043	10.110	9.302	8.598
30.	46.878	39.529	33.624	28.846	24.955	21.765	19.131	16.942	15.111	13.569	12.262	11.147	10.190	9.363	8.646
31.	49.261	41.285	34.921	29.808	25.670	22.297	19.529	17.240	15.335	13.738	12.389	11.243	10.263	9.419	8.688
32.	51.714	43.075	36.231	30.769	26.378	22.820	19.916	17.528	15.549	13.897	12.509	11.333	10.331	9.470	8.727
33.	54.240	44.900	37.554	31.731	27.079	23.333	20.292	17.805	15.753	14.049	12.621	11.417	10.393	9.517	8.762
34.	56.842	46.760	38.889	32.692	27.773	23.836	20.658	18.071	15.948	14.191	12.726	11.494	10.450	9.559	8.793
35.	59.520	48.658	40.237	33.654	28.461	24.330	21.013	18.328	16.134	14.326	12.824	11.566	10.503	9.598	8.822
36.	62.278	50.592	41.599	34.615	29.143	24.814	21.359	18.575	16.311	14.454	12.916	11.633	10.551	9.633	8.847
37.	65.118	52.565	42.974	35.577	29.817	25.289	21.694	18.813	16.480	14.575	13.003	11.694	10.596	9.665	8.871
38.	68.042	54.576	44.362	36.538	30.486	25.755	22.021	19.042	16.642	14.689	13.084	11.752	10.637	9.695	8.892
39.	71.053	56.626	45.763	37.500	31.148	26.213	22.338	19.263	16.796	14.797	13.160	11.805	10.675	9.721	8.911
40.	74.154	58.717	47.179	38.462	31.804	26.662	22.646	19.475	16.943	14.899	13.231	11.855	10.709	9.746	8.928

BEST COPY AVAILABLE

APPENDIX D-6

TABLE OF CUMULATIVE SUM OF RATIOS OF

INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=5

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	.990	.980	.971	.962	.952	.943	.935	.926	.917	.909	.901	.893	.885	.877	.870
2.	2.019	1.990	1.961	1.932	1.905	1.878	1.852	1.826	1.801	1.777	1.753	1.730	1.707	1.685	1.664
3.	3.089	3.029	2.970	2.912	2.857	2.804	2.752	2.701	2.653	2.605	2.559	2.515	2.471	2.429	2.388
4.	4.202	4.098	3.998	3.902	3.810	3.721	3.635	3.552	3.473	3.396	3.322	3.250	3.181	3.115	3.050
5.	5.358	5.199	5.047	4.901	4.762	4.629	4.501	4.379	4.263	4.151	4.043	3.940	3.841	3.746	3.655
6.	6.561	6.332	6.115	5.910	5.714	5.529	5.352	5.184	5.024	4.871	4.726	4.587	4.454	4.327	4.206
7.	7.811	7.499	7.205	6.928	6.667	6.420	6.186	5.966	5.757	5.559	5.371	5.193	5.024	4.863	4.710
8.	9.110	8.700	8.316	7.956	7.619	7.303	7.005	6.726	6.463	6.215	5.982	5.761	5.553	5.356	5.170
9.	10.461	9.936	9.448	8.994	8.571	8.177	7.809	7.465	7.143	6.842	6.559	6.294	6.045	5.811	5.590
10.	11.865	11.209	10.603	10.042	9.524	9.043	8.598	8.184	7.798	7.440	7.105	6.793	6.502	6.229	5.974
11.	13.325	12.519	11.779	11.100	10.476	9.901	9.372	8.882	8.430	8.011	7.622	7.262	6.926	6.614	6.324
12.	14.843	13.867	12.979	12.169	11.429	10.751	10.131	9.561	9.038	8.556	8.111	7.701	7.321	6.969	6.643
13.	16.421	15.256	14.202	13.247	12.381	11.593	10.876	10.222	9.624	9.076	8.574	8.112	7.688	7.296	6.935
14.	18.062	16.685	15.448	14.336	13.333	12.427	11.607	10.864	10.188	9.572	9.011	8.498	8.028	7.598	7.202
15.	19.767	18.156	16.719	15.436	14.286	13.254	12.325	11.488	10.731	10.046	9.425	8.860	8.345	7.875	7.445
16.	21.540	19.678	18.015	16.545	15.238	14.072	13.029	12.095	11.255	10.499	9.816	9.199	8.639	8.133	7.667
17.	23.383	21.229	19.335	17.666	16.190	14.883	13.720	12.685	11.759	10.931	10.187	9.517	8.912	8.366	7.870
18.	25.299	22.834	20.682	18.797	17.143	15.686	14.398	13.258	12.245	11.343	10.537	9.815	9.166	8.583	8.055
19.	27.291	24.486	22.054	19.940	18.095	16.481	15.064	13.816	12.713	11.736	10.868	10.094	9.402	8.782	8.224
20.	29.362	26.186	23.453	21.093	19.048	17.269	15.717	14.358	13.164	12.112	11.182	10.356	9.622	8.966	8.379
21.	31.515	27.937	24.880	22.257	20.000	18.049	16.358	14.885	13.599	12.471	11.478	10.602	9.826	9.135	8.520
22.	33.754	29.739	26.334	23.433	20.952	18.823	16.987	15.398	14.017	12.813	11.759	10.832	10.015	9.291	8.649
23.	36.080	31.594	27.816	24.620	21.905	19.588	17.604	15.896	14.420	13.140	12.029	11.048	10.191	9.435	8.766
24.	38.499	33.504	29.327	25.818	22.857	20.347	18.209	16.380	14.808	13.451	12.275	11.250	10.354	9.567	8.873
25.	41.014	35.470	30.867	27.028	23.810	21.098	18.803	16.851	15.182	13.749	12.512	11.440	10.506	9.689	8.971
26.	43.629	37.493	32.437	28.249	24.762	21.843	19.386	17.309	15.543	14.033	12.737	11.618	10.647	9.801	9.061
27.	46.347	39.576	34.038	29.482	25.714	22.580	19.959	17.754	15.890	14.304	12.949	11.785	10.779	9.905	9.142
28.	49.172	41.721	35.670	30.727	26.667	23.310	20.520	18.187	16.224	14.563	13.150	11.941	10.900	10.000	9.217
29.	52.110	43.928	37.333	31.984	27.619	24.034	21.071	18.608	16.546	14.810	13.340	12.088	11.014	10.088	9.285
30.	55.164	46.201	39.029	33.254	28.571	24.751	21.612	19.017	16.856	15.046	13.520	12.225	11.119	10.169	9.347
31.	58.339	48.540	40.758	34.535	29.524	25.461	22.143	19.414	17.155	15.271	13.690	12.354	11.217	10.243	9.404
32.	61.639	50.948	42.520	35.828	30.476	26.164	22.663	19.801	17.443	15.486	13.851	12.474	11.308	10.312	9.456
33.	65.070	53.427	44.317	37.134	31.429	26.860	23.174	20.177	17.720	15.692	14.003	12.588	11.392	10.375	9.503
34.	68.637	55.979	46.148	38.453	32.381	27.550	23.676	20.542	17.987	15.887	14.147	12.694	11.470	10.433	9.546
35.	72.346	58.605	48.015	39.784	33.333	28.234	24.168	20.898	18.245	16.074	14.283	12.793	11.543	10.486	9.586
36.	76.201	61.309	49.918	41.128	34.286	28.911	24.651	21.243	18.493	16.253	14.412	12.887	11.611	10.536	9.622
37.	80.209	64.093	51.858	42.485	35.238	29.581	25.124	21.579	18.731	16.423	14.534	12.979	11.674	10.581	9.655
38.	84.376	66.959	53.836	43.856	36.190	30.246	25.589	21.905	18.962	16.586	14.649	13.056	11.732	10.623	9.685
39.	88.707	69.908	55.852	45.239	37.143	30.904	26.046	22.223	19.183	16.741	14.758	13.133	11.787	10.661	9.712
40.	93.211	72.945	57.908	46.635	38.095	31.556	26.493	22.531	19.397	16.889	14.862	13.205	11.837	10.697	9.737

BEST COPY AVAILABLE

APPENDIX D-7

TABLE FOR CUMULATIVE SUM OF RATIOS OF

INCOME GROWTH RATE TO INTEREST RATES: $\sum_{t=1}^{n} \frac{(1+k)^{t-1}}{(1+r)^{t}}$, WHEN k=6

Yr.	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%
1.	.990	.980	.971	.962	.952	.943	.935	.926	.917	.909	.901	.893	.885	.877	.870
2.	1.969	1.999	1.970	1.942	1.914	1.887	1.860	1.835	1.810	1.785	1.761	1.738	1.715	1.693	1.671
3.	3.120	3.058	2.998	2.940	2.884	2.830	2.778	2.727	2.677	2.629	2.583	2.538	2.494	2.451	2.410
4.	4.264	4.158	4.056	3.959	3.864	3.774	3.686	3.602	3.521	3.443	3.367	3.295	3.224	3.156	3.091
5.	5.466	5.302	5.146	4.996	4.853	4.717	4.586	4.461	4.342	4.227	4.117	4.011	3.909	3.812	3.719
6.	6.726	6.490	6.266	6.054	5.852	5.660	5.478	5.305	5.139	4.982	4.832	4.689	4.552	4.422	4.297
7.	8.049	7.725	7.420	7.132	6.860	6.604	6.361	6.132	5.915	5.710	5.515	5.331	5.155	4.989	4.830
8.	9.438	9.006	8.607	8.230	7.878	7.547	7.237	6.945	6.670	6.411	6.168	5.938	5.721	5.516	5.322
9.	10.895	10.342	9.828	9.350	8.905	8.491	8.104	7.742	7.404	7.087	6.791	6.513	6.251	6.006	5.775
10.	12.425	11.728	11.085	10.492	9.943	9.434	8.962	8.525	8.118	7.739	7.386	7.057	6.749	6.462	6.193
11.	14.030	13.168	12.379	11.655	10.998	10.377	9.813	9.293	8.812	8.366	7.954	7.571	7.216	6.885	6.577
12.	15.714	14.665	13.710	12.841	12.047	11.321	10.656	10.046	9.486	8.971	8.497	8.059	7.654	7.279	6.932
13.	17.482	16.221	15.081	14.049	13.114	12.264	11.491	10.786	10.143	9.554	9.015	8.520	8.065	7.646	7.259
14.	19.338	17.837	16.491	15.281	14.191	13.208	12.318	11.513	10.781	10.116	9.510	8.956	8.450	7.986	7.561
15.	21.285	19.517	17.942	16.536	15.279	14.151	13.138	12.225	11.402	10.657	9.982	9.369	8.812	8.303	7.839
16.	23.329	21.268	19.435	17.816	16.376	15.094	13.949	12.925	12.005	11.179	10.433	9.760	9.151	8.598	8.095
17.	25.474	23.077	20.972	19.120	17.485	16.038	14.754	13.611	12.592	11.681	10.864	10.130	9.469	8.871	8.331
18.	27.726	24.962	22.554	20.449	18.604	16.981	15.550	14.285	13.163	12.166	11.276	10.480	9.767	9.126	8.548
19.	30.088	26.922	24.182	21.804	19.733	17.925	16.340	14.947	13.718	12.632	11.669	10.812	10.047	9.363	8.749
20.	32.568	28.958	25.857	23.185	20.874	18.868	17.122	15.596	14.258	13.082	12.044	11.125	10.310	9.583	8.934
21.	35.170	31.074	27.581	24.592	22.025	19.811	17.896	16.233	14.783	13.515	12.403	11.422	10.556	9.788	9.104
22.	37.901	33.273	29.355	26.027	23.187	20.755	18.663	16.858	15.294	13.933	12.745	11.703	10.787	9.978	9.261
23.	40.768	35.558	31.181	27.489	24.360	21.698	19.424	17.472	15.790	14.335	13.072	11.969	11.004	10.155	9.406
24.	43.776	37.933	33.060	28.979	25.544	22.642	20.177	18.074	16.273	14.723	13.384	12.221	11.207	10.320	9.539
25.	46.933	40.401	34.994	30.498	26.740	23.585	20.923	18.666	16.743	15.097	13.682	12.459	11.398	10.473	9.662
26.	50.247	42.965	36.984	32.046	27.947	24.528	21.662	19.246	17.199	15.457	13.966	12.684	11.577	10.615	9.776
27.	53.724	45.634	39.032	33.623	29.166	25.472	22.394	19.815	17.643	15.804	14.238	12.898	11.744	10.747	9.860
28.	57.374	48.401	41.140	35.232	30.396	26.415	23.119	20.374	18.075	16.138	14.498	13.100	11.902	10.870	9.977
29.	61.205	51.279	43.309	36.871	31.638	27.358	23.838	20.923	18.495	16.461	14.745	13.291	12.050	10.985	10.065
30.	65.225	54.270	45.541	38.541	32.891	28.302	24.549	21.461	18.904	16.771	14.982	13.472	12.188	11.091	10.147
31.	69.444	57.379	47.839	40.244	34.157	29.245	25.255	21.990	19.301	17.070	15.208	13.643	12.318	11.190	10.223
32.	73.871	60.610	50.203	41.979	35.435	30.189	25.953	22.509	19.687	17.359	15.424	13.805	12.440	11.282	10.292
33.	78.519	63.967	52.636	43.748	36.725	31.132	26.645	23.018	20.063	17.637	15.630	13.958	12.554	11.367	10.356
34.	83.396	67.456	55.140	45.551	38.027	32.075	27.331	23.517	20.428	17.904	15.827	14.103	12.662	11.447	10.415
35.	88.519	71.081	57.717	47.389	39.341	33.019	28.010	24.008	20.783	18.162	16.015	14.240	12.762	11.521	10.470
36.	93.886	74.849	60.369	49.262	40.668	33.962	28.683	24.489	21.128	18.411	16.194	14.370	12.857	11.589	10.520
37.	99.524	78.765	63.098	51.170	42.008	34.906	29.349	24.962	21.464	18.651	16.366	14.493	12.945	11.653	10.566
38.	105.441	82.834	65.907	53.116	43.361	35.849	30.009	25.425	21.791	18.882	16.530	14.610	13.028	11.713	10.609
39.	111.651	87.063	68.797	55.099	44.726	36.792	30.664	25.880	22.109	19.104	16.686	14.720	13.106	11.768	10.648
40.	118.169	91.458	71.772	57.120	46.104	37.736	31.312	26.327	22.418	19.318	16.835	14.824	13.179	11.819	10.684

BEST COPY AVAILABLE